The Dock and Harbour Authority

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Editorial Comments

Limerick.

For the subject of our leading article and illustrated Supplement this month, we go to a remote port on the West coast of Ireland, occupying a strategic commercial position facing the North Atlantic. It is one of the leading ports of the Irish Free State (Eire, as it is termed in the native tongue), and the progressive policy of its administrators is demonstrated in the steps described by Mr. T. F. O'Sullivan, the Harbour Engineer, for the enlargement of the dock accommodation of the port.

Limerick is a city of considerable antiquity, and its origins go back to an era of tradition somewhere in the fifth century A.D., when St. Patrick is stated to have visited it. More authentic is the record of a Danish settlement in the ninth century. Then it comes into the realm of English history in 1174, when the native king of Thomond or North Munster, was dispossessed of the town and five years later the kingdom of Limerick was bestowed by Henry II on Herbert Fitzherbert, whose tenure of the royal status did not show very great security, for Irish chieftains were frequently in possession. The city passed through various sieges, and its last experience of the kind terminated with the treaty of Limerick in 1691.

Situated on the River Shannon, some 60 miles from the Atlantic, the city has acquired considerable technical distinction of late years as the site of a great hydro-electric installation which is, in fact, the chief source of supply in Southern Ireland. This availability of large supplies of power at economical rates should have a favourable influence on the commercial development of the locality, which will further be aided by the enterprising policy of the Harbour Commissioners in extending their dock accommodation for shipping.

The present trade of the Port of Limerick is of the order of about three and a half million pounds per annum, divided as to imports and exports in the ratio of $2\frac{3}{4}$ millions and $\frac{3}{4}$ million respectively. Writing on future prospects, Mr. Daniel McNeice, the Secretary to the Commissioners, states:—

> " Government policy of encouraging home production of " cereals and developing manufactures has resulted in " reduced imports of wheat, maize, flour, sugar and cement, " which last is now being manufactured locally. Increased " imports of timber, iron and steel and raw materials for " newly-established industries and coal, etc., for cement " manufacturing have helped offset these losses. The " export trade will probably improve following the recent " settlement in Anglo-Irish relations."

Our readers will cordially endorse the desire for increased trading relations between English and Irish ports, the interruption and diminution of which, during recent years, has been a matter for regret.

The Southampton Centenary.

The centenary celebrations at Southampton remind us that some of our leading ports are of relatively modern creation. The youngest is, of course, Manchester, which has barely been in existence as a port for half a century. Barry is another instance—with a slightly longer life. On the other hand, the great proportion of British ports have quite respectable records of longevity. The origin of London is remote. Bristol, Plymouth and Dover are all of mediæval growth. Much depends on the stage at which a port assumes the dignity of the title, for many harbours with a insignificant amount of trade could justifiably put in a claim for priority of distinction if age alone were involved.

However, Southampton has now attained its "majority" and joined the ranks of the old and well-established ports. In point of traffic, it has pressed itself forward into the foremost row. Primarily, it is a passenger port, having captured from Liverpool the lion's share of the transatlantic service. Much credit attaches to the Southern Railway Company for their vigorous enterprise in catering for this sphere of traffic. By providing admirable and spacious accommodation alongside deep-water quays for the great Atlantic greyhounds and expediting on arrival the transit of passengers to the metropolis, the Railway Company has done much to foster the intercourse and business relations of this country with the United States, at the same time that it has encouraged trade and traffic with other parts of the globe, the South African service being a notable instance.

The good wishes of our readers will go out to the port administration and its staff for a continuance of the progress which has been made in the past.

Bridge versus Tunnel.

A controversy is being waged between the authorities of the Ports of Havre and Rouen as to the relative merits of a bridge and a tunnel for enabling a land connection to be made between both banks of the Seine near the estuary, so as to avoid the present circuitous route of goods in transit between towns near the coast on each side. Rouen is some 78 miles by water, or over 40 miles in a direct line from Havre, and the only means of crossing the lower Seine by road or rail is at Rouen.

As Havre is an important port in the transatlantic service and also a distribution centre for imports of cotton, coffee and many other commodities, the lack of facilities for making contact with Honfleur and its hinterland otherwise than by ferry-boat is keenly felt. The project for a bridge was first mooted 50 or 60 years ago, but was not seriously pressed. Recently, however, the Havre authorities have formulated a scheme for a road-traffic suspension bridge at the extremity of the Tancarville Canal, about 10 miles above the port, at a point where the river enters its estuarial region. The bridge would be nearly a mile in length (1,500 metres), carrying a roadway 46-ft. wide at a height of 213-ft.

To this proposal the Chamber of Commerce at Rouen has lodged an emphatic objection, not so much on a question of insufficiency of headroom for navigation, but because the possible destruction of a bridge by aerial bombardment would conceivably cut off all access to Rouen by water. To which the protagonists of the bridge at Havre rejoin that this would be a million to one chance. It would be an incredible piece of luck, they say, for an airman flying 10,000-ft. up at a speed of 200 miles per hour, to hit an objective less than 50-ft. wide.

The alternative suggestion is a tunnel, which the Havre people reject as too costly, estimating the outlay at, at least, three million pounds, as against one million for a bridge. Moreover, as a large portion of the traffic of the seaport is in oil, there are obvious objections, if not insuperable difficulties, to its passage through a tunnel.

A comparison between the respective advantages of a bridge and a tunnel at the mouths of navigable rivers has many interesting features. One important point, apparently not raised in the present instance, is that a tunnel constitutes a fixed threshold in the river bed, and unless constructed sufficiently deep at a correspondingly enhanced cost, may prove a bar to natural developments in ship construction for vessels trading to a port.

The decision in the conflict of opinion between the two ports will be awaited with much interest.

Editorial Comments—*continued*

The International Crisis.

In relation to the movement of traffic throughout the country, the sudden development of the international crisis in Europe, with its imminent threat of war and its urgent call for defensive preparations, made its effect felt in various directions, and, not least, in navigational and port affairs. The scheduled sailings of a number of vessels were suspended and, in some cases, definitely cancelled, while certain ships, notably those of German nationality, were recalled from the high seas. Indeed, a case is reported of a German ship which, learning the news of the situation while calling at a foreign port, hurriedly put out again to sea, completely ignoring all Customs and other formalities, and leaving stranded a number of its unfortunate passengers who had temporarily (as they thought) gone ashore.

As regards the ports, various difficulties of no little magnitude presented themselves in carrying on the customary routine of receiving and dispatching shipping. The calling up of reservists to the navy, to the territorial and air forces, resulted in a serious depletion of staff, in addition to which there was the necessity for emergency measures and the concern due to the impending likelihood of a hasty transfer of shipping traffic from the East to the West Coast. This general dislocation of service not only caused apprehension and inconvenience in a very marked degree, but it inevitably resulted in a considerable amount of extra expense to carry on the work in hand, added to which there has been a heavy financial burden incurred in connection with Air Raid Precautions and other measures.

Happily, for the time being, the shadow of a black cloud has been lifted, to the intense relief of all the civilised peoples of the world. But who will venture to say how long, or how short a time, it will be before it returns? Meanwhile, despite the avoidance of an actual conflict, there has been experienced an acute interference with the normal life of the community, which will take some time to subside altogether, and will leave behind an unmistakeably clear indication of what may be expected to happen if the forebodings of many responsible persons are realised. The experience has left also a consciousness of the serious imperfections in the measures for defence, and these will have to be made good without delay.

The Liège Exhibition, 1939.

The opening next year of the new Albert Canal in Belgium connecting the town of Liège with the seaport of Antwerp, is to be celebrated simultaneously by an international exhibition at the former place, which will take as its main feature the subject of Water in all its phases of form and application. Thirty large pavilions are to be erected in order to demonstrate the importance of water in its relation to human kind, to life and culture, to engineering and technical science and to the comfort, health and well-being of the community generally.

Despite the fact of its universal prevalence, few take the trouble to think of the essential part played by water in the scheme of things. Water is so common, so plentiful, that no one bothers to realise that we could not exist without it. Our bodies are mainly composed of it, it is the chief vehicle of our nutriment and the safeguard of our health.

For navigation and for all its attendant services, water is a sine qua non, and port officials are daily in intimate contact with its utilities, its difficulties and its dangers. It has been wisely said that " water is a good friend, but a bad master." Under control, it is capable of being a most efficient instrument of service to mankind; in its wilder moods, it turns on man and rends him, wrecking his patiently framed structures and spreading devastation far and wide.

Of all the varied sections of the proposed exhibition, that will be most attractive to our readers which deals with water in seas, rivers and canals, with inland, maritime, and fishery ports, with hydraulic power and machinery, and with all the processes associated with their equipment and operation.

Rail v. Coastwise Shipping.

Presidential Addresses at learned institutions are by courtesy and long tradition exempt from criticism—at any rate, at the time of delivery. Generally speaking, in recognition of this fact, such addresses are kept free from controversial topics and are confined to surveys of progress made in various departments of scientific and technical affairs. But while perhaps not deliberately provocative, it cannot be said of Colonel Szlumper's inaugural address at the Institute of Transport on October 10th, that it entirely avoided expressions of opinion on contentious matters which might justifiably call for rejoinders from those whose views were emphatically of a different kind.

This was specially noticeable in the case of the reference to coastwise shipping, in which Col. Szlumper stated that " from a national point of view, the virtue of the coasting vessel had waned in the same way that hunting is no longer the useful training ground it used to be "—a comparison not altogether apt or convincing. The allegation was further open to the comment that it could not be considered quite disinterested, coming from a source which, for obvious reasons, found the competition of coasting vessels somewhat inconvenient. It is not surprising, therefore, that a speedy protest has been forthcoming from the Coastal Trade Development Council under the signatures of the Chairman, Commander Arthur Marsden, R.N., M.P., Admiral Sir Henry Bruce, K.C.B., and Admiral of the Fleet, Sir Rogers Keyes, Bart., G.C.B., M.P., who point to the valuable services rendered in time of war by coastal seamen in mine-laying and mine-sweeping, the success of their work in the last war being attributable to their unique knowledge of the British Coast.

Without holding any brief for coastal shipping, we have supported the retention and upkeep of an adequate number of minor ports and harbours served by such shipping on the ground that it is to the national advantage to have these ports in reserve in case the major ports are disabled or abandoned or the established sea routes are rendered unsafe. The argument for harbours presupposes the continuance of the coastwise shipping services, without which the former would sink into decay from disuse. Accordingly, our sympathies are with the signatories of the protest, in their championship of the right of coastal trading vessels to a place in the sun.

The Danube Navigation Commission.

The announcement of the transference of the judicial authority of the European Commission of the Danube to the Roumanian State marks a further stage in the development and commercial exploitation of the great European river, which has been the subject of various notices in past issues of this Journal. The interesting engineering operations and problems at the Port of Soulina, described so recently as our September issue, will henceforth be in the hands of Roumanian officials, who will also be entrusted with the collection of navigation dues and the administration of the financial affairs of the undertaking. The functions of the old Commission will, in future, be limited to keeping records and making recommendations.

In view of the fact that the several outlets of the river and a large portion of its length lie in Roumanian territory, it was only to be expected that the Roumanian Government would desire to exercise their natural right to control the navigation of the waterway from the sea to the national boundary. That they intend to prosecute the programme of improvement already embarked upon is indicated by their taking over all the buildings, equipment, vessels, dredgers, mechanical and technical installations, stores and workshops, as well as the lighthouses at Serpent's Island, Soulina and St. George. Soulina ceases to be an international port and harbour; the navigation regulations, however, will be drawn up by the European Commission on the basis of proposals made by the Roumanian Government, upon whom will devolve the application and enforcement of these regulations.

The change is certainly drastic and will be far-reaching in its consequences, but there is every ground for believing that the administration of the port and the development of its commerce will be carried on as effectively under the new, as under the old, management.

The Quarterly Shipbuilding Returns.

The quarterly statistics issued by Lloyd's Register of Shipping regarding merchant vessels under construction at the end of September, do not present any more cheerful appearance than their recent predecessors. It is shown that in Great Britain and Ireland there is a decrease of 151,592 tons in the work in hand as compared with the figures for the previous quarter. Furthermore, the present total under construction—885,481 tons—is less by more than a third (299,154 tons) than the tonnage which was being built at the end of September, 1937.

In view of the indispensability of merchant shipping to the commercial prosperity of this country, the continuous and serious falling-off in the provision of fresh tonnage to replace the wastage of vessels in service is, to say the least, most disquieting, especially in view of the fact that the tonnage under construction abroad is increasing, not very strikingly perhaps (36,967 more tons than in June last), but sufficient to provide a regrettable contrast to this country's decline and to make the outlook very depressing.

The situation is rapidly becoming so deplorable, in fact, that calls for Government intervention, are by no means few or surprising. Quite recently, Mr. F. E. Rebbeck, Chairman and Managing Director of Messrs. Harland and Wolff, Ltd., the Belfast shipbuilding firm, declared that " a hideous deadlock had developed between shipbuilders and shipowners, and that the British Merchant Navy was rapidly falling below that of foreign countries." He went on to urge, as the two industries are of vital importance to every citizen of the Empire, that a Cabinet Minister should be appointed to deal with the whole situation. Some definite action of the Government would appear to be eminently desirable before it is too late to remedy matters.

The Port of Limerick

Recent Dock Extension*

By T. F. O'SULLIVAN, B.E., M.Inst.C.E.I.

PART I.
LIMERICK HARBOUR
Historical

THE SHANNON, longest river in the British Isles, is, for a quarter of its length an estuary. At the head of this estuarine portion and 60 miles from the Atlantic, lies the City and Port of Limerick. Situated thus, so far inland and at the head of waters navigable from the sea, the location of the city was pre-eminently suitable as a centre for trade and as the focus for an export and import trade serving the heart of the south-western and western parts of the country. Advantage of this favourable position was taken from the earliest times and we know that sea-borne commerce existed at Limerick, even long before the coming of the Danes.

Early in the ninth century the Northmen sailing up the Shannon to the limit of tidal waters established a base at Limerick, which they fortified, and from there penetrated to the very heart of the country, it being recorded that the Danes of Limerick raided even as far north as Armagh. Considerable trade was carried on by them from the city, and there is evidence that at that time they traded regularly between Limerick and Iceland.

The coming of the English in the year 1174 marked a change in the trade of the port and a charter from King Richard in 1197 to the city to elect a Mayor, predates by some ten years even that granted to London. As the city grew in importance so did the harbour, and from the twelfth century onward we find an increasing sea-borne trade conducted between Limerick and England, France and Spain, and later America.

In the earlier times the harbour was situated at the S.W. end of King's Island at the junction of the Abbey River and the main river, the city of that period being contained in the Island. The harbour consisted of an open basin or dock, with some quays adjoining, on the site of the present Potato Market. Later, lines of quays were built at the south end of the island fronting on the Abbey River, from Long Dock, as it was called, to Baal's Bridge, at which quays, of course, vessels took the ground at low water.

Mr. T. F. O'SULLIVAN, B.E., M.Inst.C.E.I., Harbour Engineer, Limerick

In the year 1760 the walls enclosing the city were thrown down and following that a great expansion began, especially in a westward direction. Newtown, that is that part west of the Abbey River, and which now composes the greater part of the modern city, was laid out and the river frontage began to be developed. Quays were built on the west bank of the Abbey River, and Arthur's and Honan's Quays were the first to be constructed on the South Bank of the main river.

Construction of New Harbour.

Up to this period there was only one bridge (the historic Thomond Bridge) across the Shannon at Limerick, and this—the main line of communication to County Clare—had proved inadequate to the increasing traffic. Wellesley Bridge (later to be called Sarsfield Bridge) was begun in 1821 and completed in 1835 at a cost of £80,000. This, a bridge of five arches, incorporated a swing span at the Limerick end, through which traffic to the quays had to pass.

A body, entitled the Bridge Commissioners, was established to administer the affairs of the Bridge, under the control of the Board of Works. A Committee of these Commissioners known as the "Pilot Committee" administered the affairs of the Port.

It was contemplated in the original design of the Bridge to form a large Wet Dock at its eastern side, with a weir wall running from the south abutment of the bridge to Custom House Quay, and with both Arthur's and Honan's Quays forming its southern and western sides; a set of locks, with a Lie Bye, was constructed (see Fig. 1), but for various reasons the weir wall was not built and the dock was never completed.

The trouble and delay in negotiating the swing bridge, together with the small depth available above the bridge—at most 12-ft. at H.W.O.S.T.—soon turned attention to the need of further and better accommodation for shipping. The Bridge Commissioners in 1839 began the construction of the long line of quays reaching from the bridge westward to the docks along the South Bank of the river. These quays comprising Harvey's, Howley's, Bishop's, Mt. Kennett and Steamboat Quays and also the North Strand Quay, which dates from this period, were constructed of native limestone laid as dressed ashlar masonry, and are still in perfect condition and in constant use.

Limerick Docks

Vessels lying at the quays had to lay on the ground at low water, and also were subject to damage during gales and high tides, notably in 1839, when it was estimated that £30,000 of damage was sustained at the port as a result of a severe gale. The Commissioners, therefore, began to investigate schemes for the construction of a wet dock " in which sharp vessels could lay afloat in safety, at any state of the tide." Several eminent Engineers were consulted and different schemes put forward, one of them being the construction of a barrage, with locks across the Shannon, at or about the site of the present Docks. Eventually it was decided to construct the present wet dock. Work was begun in 1849, to the design and under the supervision of the Engineers of the Board of Works. The Contractor, after some time, abandoned the work, and it was completed entirely by the Board of Works and opened in 1853, the cost being £80,000.

The Graving Dock was constructed in 1873 at a cost of £21,000. On its completion the port was considered a safe, well constructed and well appointed harbour and one of the foremost in Ireland.

Limerick Harbour Commissioners

In 1867 was constituted, by Act of Parliament, the body known as the Limerick Harbour Commissioners, which took over the control of the port and has administered its affairs up to the present time.

Description of Quays and Docks

The quays are situated on the town reach of the river and on the south side extend from the Custom House Quay westward to the Wet Dock, a distance of nearly a mile; on the north side and west of Sarsfield Bridge are the North Strand Quays.

Above Sarsfield Bridge, in the older part of the harbour, the quays are little used, being suitable only for comparatively small vessels. Below the bridge, and between it and the docks, the quays have always been much in use, vessels drawing 17-ft. are accommodated. and in the days of sailing vessels it was no unusual occurrence for them to be lying three and four abreast there.

* A Paper read before the Institution of Civil Engineers of Ireland on 4th April, 1938.

Port of Limerick—continued

The Wet Dock is built of the south side of the river at the western end of the quays, its dimensions—before extension—were 810-ft. long by 390-ft. (av.) wide. The entrance, at the eastern end, faces upstream and is 70-ft. wide, with steel cellular Dock Gates. Depth on sill H.W.O.S.T. 22-ft. 6-in. The dock had a water area of 7½ acres and provided a wharfage of 2,200-ft.

The Graving Dock opens from the Wet Dock at its eastern end, the entrance, which is 45-ft. wide, is closed by a steel caisson. It has a length of 428-ft. and a depth on sill H.W.O.S.T. of 17-ft.

Other Works

Considerable difficulty was always experienced in navigating sailing vessels in the upper reaches of the river near the harbour, owing to obstructions in the navigable channel, and the tortuous course of the river, there being three sharp bends in the first seven miles below the city. It was not unusual in those days for as many as 20 vessels to be at anchor in the pool at Cain's Island, 9 miles away, awaiting a favourable wind and tide to proceed to the harbour.

Accordingly the Commissioners installed a system of river navigation lights and beacons as far as Beigh Castle. The removal of obstructions was undertaken, and the Cock Rock, a large accumulation of boulder clay, a shoal for two-thirds of the width of the channel was removed, as well as some other shoals. The large reef of rock that existed outside the dock entrance was broken down with a Lobnitz rock breaker and dredged to a depth of 2-ft. below dock sill. Several of the sharper bends in the river were eased from time to time by dredging.

Dredging

The level of the dock sill is the governing factor in the dredging of the navigable channel, and maintenance dredging is required at times to keep to the required 2-ft. below this level. Owing to the large freshwater discharge in the river the channel is maintained to the required depth by scour to a great extent, and only in exceptionally dry periods is there a necessity of continuous dredging. During these periods when the freshwater discharge is low, the silt moves up into the upper reaches of the port, the greatest deposit occurring in the reach off the dock entrance, where a deposit of 4-ft. has been recorded. The Shannon Power Scheme, since its completion has materially affected the scour, since the freshwater discharge is now controlled there is less frequency of the great freshets, which were so effective in scouring away the silt.

Tidal Data

The tidal range at Limerick Docks is 18-ft. 9-in. H.W.S.T. and 13-ft. 6-in. H.W.N.T. Tides are very much subject to variations from several causes, the principal of these being the wind. Strong southerly or westerly winds will keep the water up in the river and will produce a great high tide, whereas northerly or easterly winds have exactly the opposite effect. Following is a record of normal and abnormal tides recorded on the Dock Gauge:—

	Dock Gauge	Ordnance Datum
H.W.O.S.T.	22-ft. 6-in.	+17.55-ft.
Highest H.W.S.T.	27-ft. 0-in.	+22.05-ft.
L.W.O.S.T.	3-ft. 5-in.	— 1.53-ft.
Lowest L.W.S.T.	1-ft. 6-in.	— 3.45-ft.

The levels of Low Waters are now appreciably affected by the discharge from the Shannon Power Scheme.

PART II.

DOCK EXTENSION AND NEW ENTRANCE

Need of Extension

Not many years after the completion of the Wet Dock, the need was felt for greater accommodation. The size and number of vessels using the dock had increased rapidly and the advent of the steamship accentuated this need. The following tables help to illustrate the position:—

Tonnage of Largest Vessel to enter Dock.

1870	970	nett reg.	tons.
1890	1.920	"	"
1926	4.293	"	"

Total Tonnage of Vessels Paying Dues in Dock.

1870	64,112	nett reg.	tons.
1895	134.681	"	"
1926	160,151	"	"

This increase made for congestion in the dock, which had become acute in the post war years.

Need of New Entrance

The original design of the Wet Dock contemplated having two entrances, the main one at the N.W. corner to serve seaborne traffic and a narrower entrance at the E. end to serve river craft and barges for the canal system. However, during construction it was found that the depth at which rock existed at the N.W. corner was such that the cost of constructing the entrance at this point would be prohibitive, as the plant and methods in use at that period were not adequate to such work. The N.W. entrance was not constructed at all, and the only entrance was formed at the eastern end of the dock facing upstream, the completed entrance having a width of 70-ft. At this point rock occurs only 2-ft. below sill level.

The disadvantages of the eastern entrance were apparent from the beginning. A vessel had to swing in a complete circle either entering or leaving the dock. This operation entailed some danger for larger vessels, and a serious delay occurred in the vital operation of docking. The narrow width of the river channel, 600-ft. opposite the entrance, and a more or less constant downstream current, sometimes amounting to three knots, also contributed to make the swinging of vessels at the entrance a slow operation containing some elements of risk. Coincident, therefore, with the demand for extension of the dock there was also a demand for a new western entrance. Another factor which also called for attention was the stability of some of the walls in the dock, to which reference will be made later. Furthermore, it was emphasised that any extension should be such as would provide the extra accommodation, principally on the south side, where congestion was the greatest and where berthage was most in demand on account of the shorter cartage from the ship's side to stores and to the city.

Sheet Piling North Jetty

Schemes of Extension Proposed

From as early as 1883 when the first one was proposed by the then Harbour Engineer, W. J. Hall, several schemes for the extension of the dock and for a new western entrance had been put forward. None of these had been carried out, however, for different reasons, the principal one of which was lack of financial resources. 1926 the Commissioners promoted the Limerick Harbour Act (1926) in the Dáil, empowering them to acquire lands and construct an extension of the existing Wet Dock and a new western entrance.

Plans were prepared and tenders received for the work, but the work proved to be beyond the financial capabilities of the Board. In 1931 the author put forward a scheme, which it was proposed would be carried out in successive steps, and this was approved.

The scheme proposed to proceed with the works in the following order:—

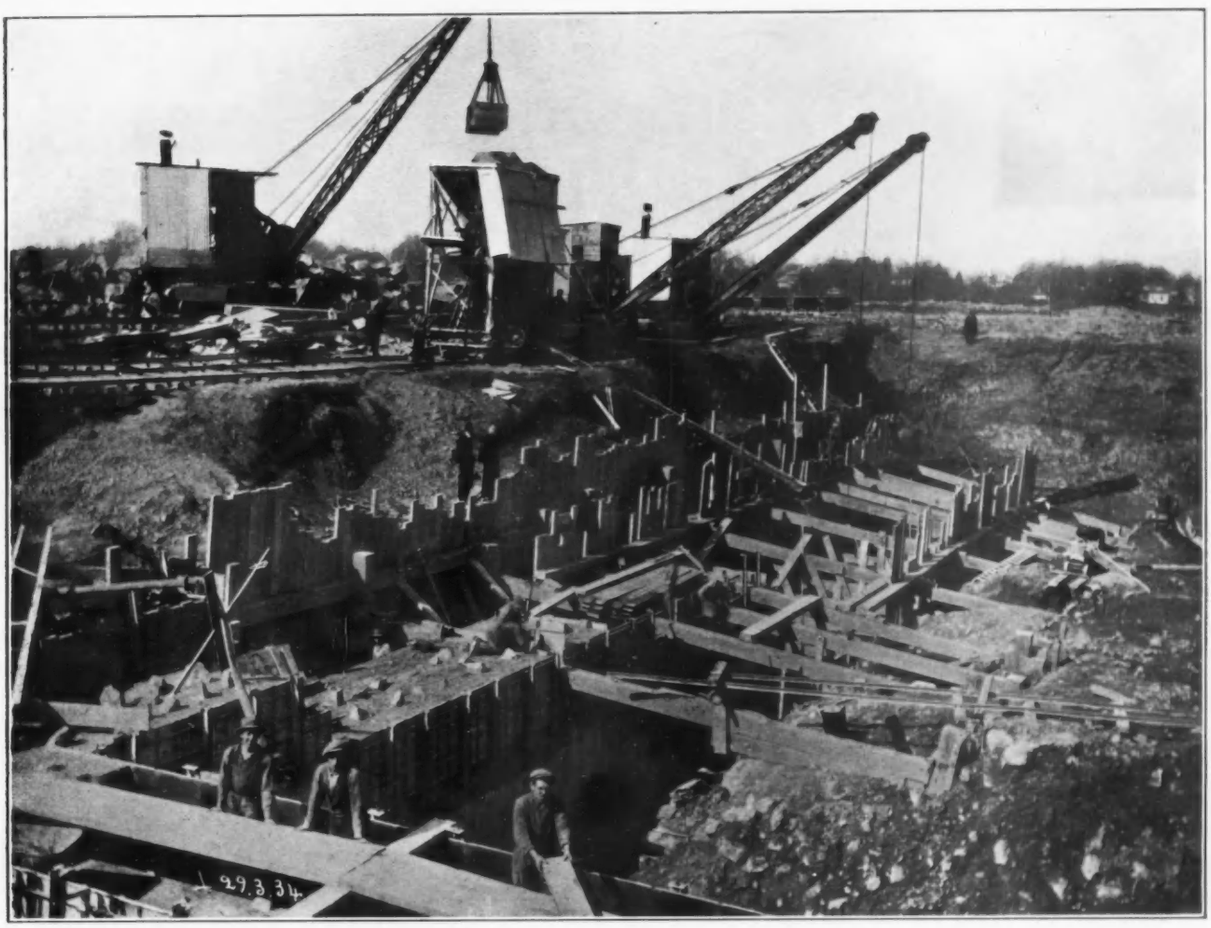
1. Dock Extension.
2. New Gate Chamber.
3. New Western Entrance.
4. The closing of the Existing Eastern Entrance and other works.

In 1932, tenders were invited for Part 1, Dock extension, and that of Messrs. T. J. Moran & Co., Ltd., Dublin, was accepted at £84,288.

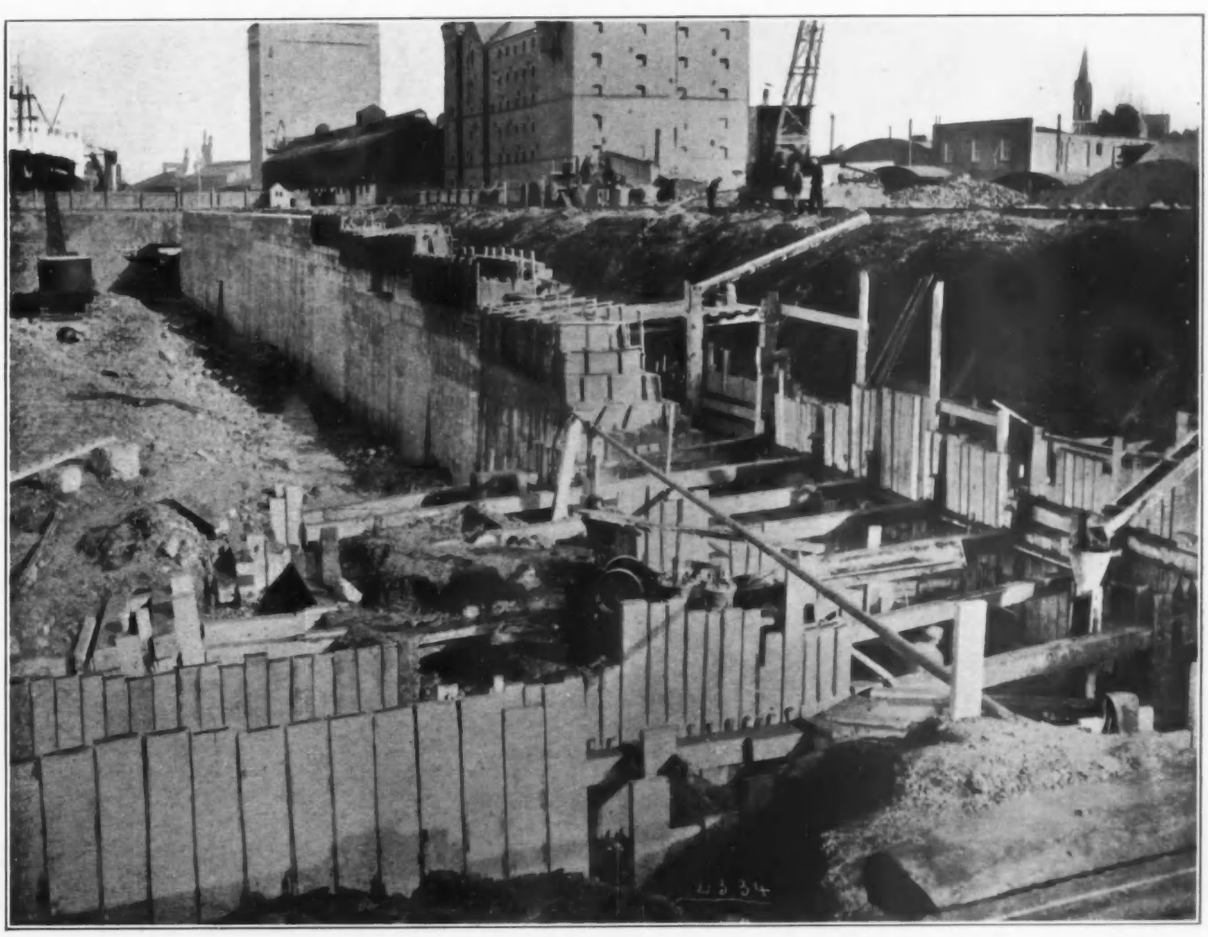
Preliminary to Contract Works

Previous to the letting of the contract the Commissioners had purchased from Limerick Corporation 20 acres of the lands of Corcanree adjoining the docks at the western end. The land had been reclaimed from the river and for the past forty years had been used as a dump for Corporation refuse. Preliminary borings had been carried out over the site of the proposed extension and entrance, to determine the nature of the ground, and the depth at which rock existed.

Port of Limerick



Dock Extension—Timbering and Concreting of West Wall



Dock Extension—showing Timbering and Concreting for Dock Walls

Port of Limerick—continued

Description of Extension

As will be seen from Fig. 2, the plan provided for an extension of the South Wharf by 555-ft., new N.W. and N.E. wharves, and the demolition and removal of the existing west wall of the dock. This wall, part of the original dock, was unstable for nearly two-thirds of its length and could not be used for the discharge of heavy cargo. The bottom of the extension was to be—8.50-ft. O.D., or 1½-ft. lower than that of the dock.

So that the usual traffic of the dock could be carried on for as long as possible with the minimum of disturbance, it was specified that the west wall, with 50-ft. of roadway adjoining, be allowed to stand until all the other work of the extension had been completed.

The walls of the new basin were to be of mass concrete, founded on rock, with the exception of the N.E. wall, where a piled foundation was provided for. It was expected that a good deal of water would be encountered during the course of the work, and that considerable pumping would be necessary.

All the spoil recovered from the excavation was to be used to fill in the low lying land adjoining, so as to make it available as building sites within the Commissioners' area.

Work was begun on Part I, Dock Extension, in May, 1933.

PART III.

PROGRESS OF WORKS, PART I. (DOCK EXTENSION)

Sheet Piling at North Jetty

As soon as General Excavation of the site had begun, work commenced on the driving of the line of Steel Sheet Piling along the river side opposite the extension. This Sheet Piling serves the double purpose of acting as a cut off for the new basin from the river, and at a later date it will be incorporated into the North Jetty, and will form part of one of the approach walls to the proposed new entrance.

A temporary timber crane gantry was erected along the line of piling and test piles were driven at three points on the line. From the data so ascertained, the length of piling required was decided. Larssen Sect. IV was the type of section used, containing between .25 and .35 per cent. copper. In all 182 piles were driven, almost all of them being driven to a depth of from—18.00-ft. to 21.00-ft. O.D., and into the "red" boulder clay. The piles were handled and pitched by a 5-ton steam loco crane, and driven with a double acting steam hammer. Occasional difficulty was met in driving, principally from boulders. On completion of the driving the tops of the piles were burnt off to the required level with the oxy-acetylene flame.

The piling is anchored at two points. The top anchorage consisting of 1⅛-in. diam. M.S. bars 30-ft. long at 13-ft. 1½-in. centres, anchored back to 6-ft. by 6-ft. by 1-ft. 6in. reinforced concrete blocks. The bottom anchorage is made up of 3-in. diam. M.S. bars at 5-ft. 3-in. centres, 50-ft. long, in two lengths, joined by a turnbuckle connection and connecting the piling at the lower waling to a continuous reinforced concrete beam 6-ft. deep and 2-ft. wide running the full length of the line of the piling and parallel to it.

The lower waling is built up of 2—10-in. by 3½-in. M.S. channels and 12-in. by ½-in. M.S. steel plates.

The top cover plate is built of 2—4-in. by 4-in. by ½-in. M.S. angles and 13¼-in. by ⅜-in. M.S. steel plates. All the waling and cover plate sections are bolted through to the piling.

When Part 3 of the works is undertaken this line of piling will be incorporated on the North Jetty and dredged down at the river side to 1-ft. below dock bottom.

General Excavation

The main plant used by the Contractors consisted of 1—¾ cu. yd. Diesel Dragline Excavator, and 1 No. 4 Ruston Shovel Excavator. The spoil was loaded direct into 40 cu. ft. side tip wagons, running on a 2-ft. gauge track, and was hauled direct to the tip by Montana Diesel Locos, of which there were five in use.

The manner of excavation was generally as follows:—

The site was first excavated down to the level of +22.70-ft. O.D., the level of the coping. The basin was next excavated out in steps, the first, to the level of +12.00-ft. O.D., the sides of the cut being such as to be self-supporting. The next cut was taken down to level +1.00-ft. O.D., and the trenches for side walls roughed out. After the walls had risen above the level of +1.00-ft. O.D., the remainder of the basin was excavated down to dock bottom level—8.50-ft. O.D.

Timbering for the side of the cut began at level +12.00-ft. O.D., and was carried down to foundation level. The basin side of the wall trench was timbered from level +1.00-ft. O.D. The timbering consisted of 12-in. by 12-in. shores. 12-in. by 12-in. braces, 12-in. by 8-in. waling pieces and 9-in. by 3-in. sheeting.

Excavation for wall foundations began about 100-ft. west of the S.E. corner of the old dock, for the new south wall, and worked around the new basin to the N.W. corner, the construction of the walls following immediately behind the excavation.

Foundation excavation was carried out by hand, the material being loaded into 1 cu. yd. tipping skips, which were hoisted out of the trench by 5-ton steam loco cranes of which there were 4 standing on the bank at the +22.70-ft. O.D. level, and thence loaded into wagons and hauled to the dump as before.

The west wall of the dock, and 50-ft. of roadway adjoining, was left standing, the back slope of the excavation being approximately 45°, the whole acting as a dam between the old and new basins.

During the early and heavier part of the work, excavation was carried on in two shifts

South Wall Trench Excavation, showing Boulder Clay and Cap Rock

Type of Materials Excavated

As stated before, the site had been used for dumping refuse for the past 40 years, so that in places, to a depth of 10-ft., there was a layer of miscellaneous rubbish. Under this there was a depth of 10-ft. of "blue" alluvial clay, deposited originally as river silt and now compressed; under the blue clay and overlying rock was a layer of "red" boulder clay from 10-ft. to 15-ft. thick.

The "blue" alluvial clay, a bluish grey in colour, while damp, dries out to a light grey somewhat the same colour as Portland cement. It is of an even texture weighing 110 lbs. per cu. ft., and when damp or dry would stand at angle of 45° or more, but when broken out and wet, however, it ran like silt.

The "red" boulder clay, overlying the rock, is a tough, tenacious, heavy clay containing a large proportion of stony material from large boulders down to gravel and sand. It has a weight per cu. ft. of 141.3 lbs. In 70,000 cu. yds. of this material excavated, 250 boulders ranging from 1 cu. yd. to 4 cu. yds. were measured, the total cube measurement being 437 cu. yds. Boulders of less than 1 cu. yd. and which composed the greater part of the stony material were not noted or measured. This clay is watertight and non-absorbent and it was noted during construction that on resuming work on trenches, that had stood flooded to a depth of 6-ft., after pumping out and clearing away the top 6-in. of clay the surface was again quite hard and did not puddle. Hall, in "Limerick Dock Walls," *Min. Proc. Civ. Eng.*, 1888, describes this as blue clay with gravel, but the author cannot agree with this description. It is of a distinct purple red colour. It is so tenacious and contains such a large proportion of stony material that it is difficult to excavate it by hand.

Underlying the red boulder clay is the rock, typical Limerick limestone, hard and weathering well. (All the existing walls of the docks and quays are built of this material in ashlar masonry.)

The top 3 or 4-ft. of this rock is open and fissured and lying in slabs sometimes up to 10-ft. wide, the fissures being full of fine clay, which had also bedded itself under the slabs.

Preparation of Rock Surfaces for Foundations

All the fissured rock was blasted and excavated and all clay removed, steps were formed in the bedrock to key the walls to the rock. All surfaces were washed down with water under pressure, before concreting began.

Port of Limerick—continued

Pumping.

It had been anticipated that considerable pumping would be necessary, owing to the proximity of the new basin to the old dock and the river, however, the opposite was the case. There was little, if any, percolation into the excavation, and most of the pumping necessary was for rain and surface water or springs, which were encountered in a few instances.

Three double diaphragm pumps dealt with water in the foundation trenches, pumping it into the basin area, where it found its way to a sump and was pumped from there by a 4-in. centrifugal pump into a drain at the west end.

South Wall Stepping Rock Foundation

Sewer Diversion

Close to the intersection of the south and west walls of the extension, a city sewer 4-ft. 6-in. high, built in masonry, passed close to the excavation.

A length of 54-ft. of the sewer was taken up and relaid in 36-in. diam. reinforced concrete pipe on a reinforced concrete slab. The new piped part being diverted at the maximum to 9-ft. 6-in. off the line of the sewer at the intersection, to prevent any possibility of leakage from the dock. A manhole was constructed at the point of intersection between the old and new parts of the sewer.

Concrete in Dock Walls

It was specified that the finished concrete should contain a fixed quantity of Portland cement, and that the aggregate should be so graded that the resulting concrete would have a high density.

Sand.—Trouble was at first found in obtaining suitable supplies of sand. Many pits in the district were inspected and rejected, principally on account of too high a percentage of loam, or organic matter, or again because they were not properly worked. Eventually one pit was found suitable, and almost all the supplies for the works came from this source. Sand supplies were inspected daily and subjected to tests from time to time for organic matter.

Broken Stone.—Rock obtained during the course of excavation was allowed to be used, if suitable, and supplies were also obtained from a quarry two miles distant from the site. All crushing was done at a central point at the works, the plant consisting of a 20 by 10 steam operated crusher and screen.

Cement.—All the Portland cement used, was imported direct by steamer to the site and stored under supervision. Samples were taken of each cargo as it arrived and from time to time from the cement in store, and sent to Professor H. N. Walsh, M.E., for testing. The tests over a period of two and a half years, when over 4,000 tons of cement were used, showed an even consistency of quality in excess of B.S.S. requirements.

The Specification required the following weights of cement per cu. yd. of concrete, finished and in place:—

1:8 (nominal) concrete 405 lbs. Portland Cement.
1:6 (nominal) „ 540 „ „

(The figures 8 and 6 above denote the sum of the separate volumes of fine and coarse aggregate).

The quantity of cement used daily was recorded and each week a check was made of the amount of cement used and the amount in stock against the amount of concrete finished in place.

The final check of cement used against concrete finished and in place was remarkably close.

Aggregate.—It was specified that the broken stone and sand for aggregate should be so proportioned that the resultant concrete would have workability and high density and strength. Samples of both stone and sand were sent to Professor H. N. Walsh, M.E., for analysis and to determine the correct proportioning of the materials.

The following are the proportions of the mix designed for 1 : 8 (nominal) concrete:—

Cement	224 lbs. (2 bags).
Sand	9.75 cu. ft. (damp).
Stone	12.00 cu. ft.
Water	14.40 gals.

With very slight variation of the stone content, this mix was adhered to throughout the work.

Concrete.—The resultant concrete was very satisfactory. Tests for weight of samples taken from time to time gave an average of 146.8 lbs. per cu. ft.

Batching and Mixing.—The batching and mixing plant stood on rails on the bank over the position of the walls. The batching unit used was designed specially for the work, the "Winget" Travelling Volume Batching Plant. It was built on a braced angle steel frame, on top of the frame was a two compartment bin, with double clam gates and operating gear, one compartment each for stone and sand. Under this was the batching compartment, the sides of which were moveable, and could be adjusted to give the required volume of each material. This compartment had a regulating valve to feed to the mixing drum which stood directly underneath at ground level. The mixing unit consisted of one "Winget" No. 10 (14/10) closed drum mixer. The concrete was conveyed direct from the mixer in chutes to the shuttering. For the comparatively small amount of work not accessible to the batching and mixing plant smaller mixers were used, the batching being carried out as ordinarily, in timber boxes.

Shuttering.—Timber casing was used for foundations, and above trench level steel forms were used exclusively. These gave a good surface finish, and when care was taken, gave a very true line and profile.

All concrete was deposited in layers of not more than 2-ft. in depth, and was spaded and rammed in position. In this kind of work, in the future, dealing with large masses of concrete, the author favours vibrating as a means of consolidation.

Displacers were specified to be used, the quantity in any given section not to exceed 15 per cent. of the total volume of concrete in the section.

Concreting of Walls North Roundhead

Wall Sections

Section on Rock.—Since the building of the docks there have been three wall failures, two in the basin and one in the River Wharf. Furthermore, the west wall of the dock was in a state of instability for the greater part of its length and had been condemned as unsafe for many years. Two other lengths of River Wharf had at one time shown signs of movement, and had had to be tied. All these unfortunate experiences in regard to the old walls are not to be wondered at, perhaps, when the type of section used is noted. (See Fig. 3.) The walls were well built in ashlar masonry and where founded on rock were still in good condition. The design of the sections in the Extension, therefore, errs if anything on the side of safety. The following is a comparison between old and new wall sections:—

	Old	New
Base / Height	.29	.54
Sect. Area sq. ft.	199	280

In both cases shown above, the height is taken from coping level to the level of the old dock bottom—7.00-ft. O.D.

Port of Limerick—continued

The new wall sections, for their height from coping level to the bottom of the extension,—8.5-ft. O.D., have a Base Height ratio of .55 and sectional area of 305 sq. ft.

The principal data used in the design of the sections are as follows:—

Weight of concrete	...	145 lbs. per cu. ft.
„ „ clay	...	110 „ „
ϕ		35°
Surcharge ...	...	3 cwts. per sq. ft.

The backfilling at the rear of walls was carried out in layers of 18-in., well rammed, the heavier boulder clay being placed immediately over the steps at the back of the wall.

Section on Boulder Clay. –As work proceeded with the construction of the south wall, it was decided to sink a trial pit, to explore further the nature of the ground for foundations and the depth of rock especially in respect of the N.E. wall and the proposed Gate Chamber, the proposal to construct which was then under way.

The site selected was at the north side of the extension near the junction of the N.E. wall and the N. Roundhead, and close alongside the site of the proposed Gate Chamber.

The pit began at level +10.00-ft. O.D., and was sunk to a final level of—20.00-ft. O.D. The "red" boulder clay was met at —2.00-ft. O.D.

It was not considered economic to found on rock below level—15.00-ft. O.D., and the original section proposed for this wall contemplated a piled foundation with sheet piling along the toe. The density of the clay, however, and the large boulder and stone content made it a doubtful matter whether sheet piling or reinforced concrete piles could be driven to a sufficient depth. Accordingly a series of pressure tests were made in the trial pit, on the boulder clay to determine its suitability to found on.

The tests were carried out as follows:—A 20-ton jack was set up at the bottom of the pit, the thrust from the jack being taken by a 12-in. by 12-in. by ¾-in. steel plate which rested on the clay at the bottom, the reaction of the jack was taken up by a large steel plate bearing on 12-in. by 12-in. timbers running the full width of the pit, and strutted to the timbering and the side walls. A rod terminating over the top of the pit, in a scale graduated in .01-in. was supported on its base only, on the 12-in. by 12-in. bottom plate. Watches were synchronised and while one operator at the bottom of the pit applied the load and read the load gauge, another read the scale on top by means of a level, set up outside and away from the pit. After a series of loads had been made, the pit was sunk another 1-ft. and another series taken.

From the data so obtained, load-time, load-settlement and time-settlement curves were plotted. Loads rapidly applied up to 7 tons per sq. ft. caused a settlement .19-in. and on the load being left on for a period of 3 hours the settlement increased to a total of .25-in., on increasing the load rapidly to 11.13 tons per sq. ft. a further settlement of .18-in. was found when the gauge reading fell away. One half of the settlement was elastic and disappeared on removal of the load.

As a result of the tests it was concluded that the boulder clay could be loaded up to 4 tons per sq. ft., without causing undue settlement. A new wall section was designed for these conditions with a wide base, the foundation of which was 6-ft. to 8-ft. below dock bottom in the boulder clay. This type section was used for all the N.E. wall, the South Roundhead and a short section of the N.W. wall.

The author wishes to express his thanks to Professor P. F. Purcell, University College, Dublin, who was consulted on the matter of tests and design, for the valuable aid and advice which he gave.

(To be continued)

English Ports and Estuaries in their Geographical Setting

*The Mersey Entrance**

By Miss M. CHRISS and Mr. G. HAYES
of the Hydrographic Department, Admiralty

The Port of Liverpool is of comparatively recent date, both geologically and commercially, indeed, it is doubtful whether the present estuary was in existence in Roman times, while its importance as a harbour for commerce is hardly three centuries old. The Mersey basin, its approaches and the adjacent coasts, presents a large number of geographical problems, of very diverse character.

In its broadest terms, the story of Liverpool Bay is firstly, a gradual subsidence of the sea bed and the coastal line, by which some basic changes in drainage came about; then considerable loss of inhabited land at a later date, possibly due more to geographical than geological causes; then comes a halt and the deposit of sand on the coast from Liverpool to the northward begins, by which much of the area lost in the second period is recovered though in a state useless to man. With the change in level, the rivers bring their silt down to the Bay and we find the familiar combat between the scour due to the greater flow, and the increased deposit of silt, for a channel to the sea. Lastly, man takes a hand in the game and trains the course of the river outlets into ordered routes and dredges away the silt.

Coming to historic times:

(1) Beginning at the eastern end of Anglesey, land extended outwards for a considerable distance, possibly as far as the present Constable Bank; the present present Conway estuary was the land of Prince Helig, "Morfa Rhiannedd," of which the inundation is familiar in Welsh legend; the ruins of the buildings of Llys Helig are clearly visible at low tide through the water. The original mouth of the Conway, running between Llandudno and Colwyn Bay, is a more geological speculation.

At about Rhyl begins the remains of the submerged forest that continues well into Liverpool Bay; tree stumps are uncovered at extreme low tide even to-day.

The present Great Burbo Banks are the site of what was inhabited, though probably very swampy, land in Roman times, though the discovery of hewn causeway stones suggests that something corresponding to the present Rock Channel existed even then. This may have been an outlet stream from the shallow mere by which the present Mersey Basin was represented; the Mersey itself almost certainly had its original outlet into the Dee which it joined just below Chester, though the change of this bed may have taken place somewhat earlier.

Passing along the Lancashire coast, there are records of many places now beneath the sea; the archives of Cockersand Abbey contain many such references and in 1503 Sir Henry Halsall very properly defended himself against a royal demand for rent due on his property of Argameols, by bringing evidence to show that the said place had been "drowned and annihilated with the high sea" many years before; the site of Argameols is estimated to lie off the coast opposite modern Ainsdale.

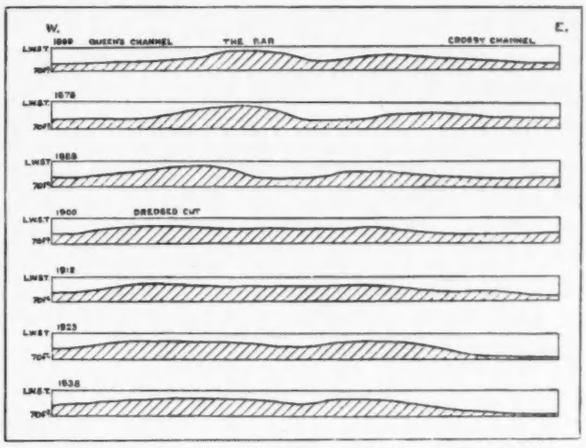
Although the general appearance of the estuary of the Mersey in the Middle Ages must have approximated to that known to-day, the work of erosion of the enveloping coast went on. The north coast of Cheshire at the extremity of the Wirrall peninsula suffered most and for longest, but the Lancashire coast up to the Ribble also lost much land and it is estimated that by the sixteenth century the coast line had receded to about the line now followed by the Liverpool and Southport Railway.

It was not until late in that century that the familiar sandhills along the Formby coast began to form; amongst other authorities it is interesting here to quote a paper read by Mr. J. Lomas before the annual meeting of this Association in 1903. The sandy foreshore south of the River Alt is the oldest part and was in existence in 1565, but there is good evidence that

* Paper read before Section E (Geography) at the British Association Meeting at Cambridge, August, 1938.

English Ports and Estuaries in their Geographical Setting—continued

the formation at Formby Point did not begin until well in the 17th century while it had scarcely reached the present Ainsdale a hundred years later.



Sections through Entrance Channel, showing depths 1869-1938

Of this fascinating subject we have no space to say more than to mention the causes of formation and the checks to spreading. The prevailing wind, of sufficient strength to lift the sand happens to strike the coast at the optimum angle of about 15°; the presence in profusion of "Arundo arenaria," commonly called "marram-grass" or "star-grass," rivers or streams across which the sand does not carry, and the supply of material from the river deposits and coastal erosion.

Those who know the Mersey will appreciate the point of the old jest that " the quality of Mersey is not strained"; one estimate is that about 50,000 cubic yards of silt are deposited at every tide; another, that nearly 12 million cubic yards are deposited every year. Geological analysis has pointed to this material's being largely mill stone grit from the Pennine regions.

In addition to the insoluble materials brought down by the Lancashire rivers there is not an inconsiderable amount of soluble solids in the water; the Ribble alone has been estimated to carry 400,000 tons annually. The " star-grass," which has been protected by enactments since Elizabethan days, allows the hill formation, with a limiting height of about 70-ft., and it prevents that flat spreading of sand, which is doing so much damage in districts such as the southern shore of the Moray Firth in Scotland.

There is good evidence that for a time there was a harbour and pier at Formby, more probably up the River Alt than on the sea coast; and it has been stated that in 1700 there was a great discussion whether Docks should be built at Liverpool or at Formby, but the last house of old Formby is known to have been covered in blown sand in 1739.

Nearly a dozen maps between 1577 and 1789 show what looks like a sea port at the entrance of the River Alt, called Altmouth, but it is now generally accepted that this was a myth, created by some early map-maker and faithfully copied by his followers.

The two light houses built at Leasowe on the Wirrall coast in 1763, to give a leading line in the Rock Channel, have been claimed by local enthusiasm as the first ever built in England, but others have precedence; the outer light tower is now hardly visible at low water, though when built it stood nearly a quarter of a mile inland from the High Water line.

A Beacon on the Black Rock, on the western side of the Narrows, existed in the 17th century, if not earlier and is the oldest sea mark in the vicinity, it was lighted in 1830.

The survey by Mackenzie of 1760 shows that the Formby Channel still had 3 fathoms on the Bar at Low Water, and that it was buoyed, with a Perch on Crosby Sand. But is was not until Nimmo's surveys of 1828, that serious interest was taken in this channel, which then became known as "the New Channel." It was buoyed "at very considerable expense by the Liverpool Dock Trustees" and an article in the Liverpool Courier of May 29th, 1833, which describes the state of the harbour approaches in some historical detail, goes on to say: "when the new floating light, intended to be placed in the Crosby Channel opposite its eastern entrance shall be exhibited, its passage will be rendered perfectly safe." This was established in 1834, but is known as the Formby Light Vessel; the present Crosby Light Vessel was not established until 1840. The Bar buoy was replaced by a Light Vessel in 1873.

By 1888 the depth on the Bar had become reduced to 11-ft., which is the least recorded, and shortly after that date the dredging began.

The Crosby Channel may be mentioned as an example of the effect of a large body of water flowing out of a narrow entrance; the result has been an effective scour all along this portion and refutes a theory which had been advanced that the dissipation of water energy outside a neck such as this would lead to an increased deposit. The results have only to be compared with those in broad estuaries, such as the neighbouring Dee or Ribble to see the advantage gained in the Crosby Channel from the bottle neck of the Mersey Basin.

(A series of diagrams was then shown by which the successive changes in the entrance channel, from the end of the seveteenth century to the present day, were explained).

Has the Mersey Entrance now almost reached a state of equilibrium between the maintenance of the revetments and dredging on the one hand, and the deposit of silt, combined with growth of sandbanks, on the other? It is probable that some further extension of the training walls at the seaward end will become necessary if the Taylor Bank grows outwardly—a development which the revetment itself may encourage—but the Queen's Channel has now reached the deeper sea bed which slopes gently to the 15 fathom plateau of the bed of the Iriish Sea and the effects of deposit may be sufficiently dispersed to stay the need for any greatly extended efforts of control for some years to come.

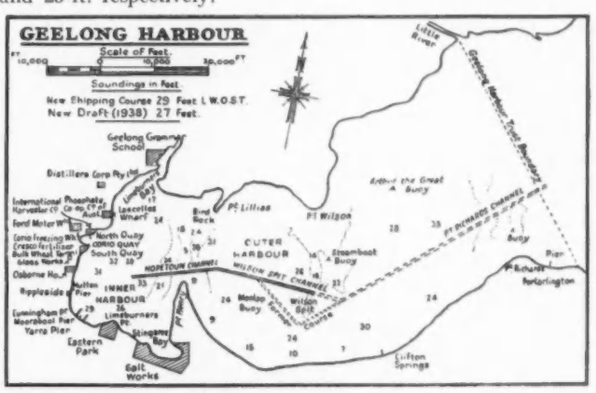
Correspondence

To the Editor of "The Dock and Harbour Authority."

Dear Sir,

In your issue of August, 1938, among " Notes of the Month," there appears a paragraph in relation to this port, and in which some inaccuracies occur.

For your general information, it is pointed out that this work, commenced at the end of 1934, has now provided a straightened shipping course of a maximum depth of 29-ft. L.W.O.S.T., providing for a draft of 27-ft. Previously, these were 26-ft. 6-in. and 25-ft. respectively.



Geelong has been for many years the main wheat export centre for the State of Victoria, and the anticipation is that this trade will increase in the future.

The principal difficulty regarding draft of vessels was in relation to this trade—vessels in some cases had to proceed to Williamstown to complete loading.

Yours faithfully,

R. R. PHILLIPS,

The Geelong Harbour Trust Commissioners. Secretary.

Secretary's Office, Geelong.

September 7th, 1938.

Obituary

With great regret we have to record the death, in his ninety-first year, of a very distinguished port and harbour engineer, Sir John Purser Griffith, M.A.I., who throughout his long life had taken a prominent part in technical affairs, mainly in Ireland, but also in Great Britain. He was of Welsh nationality but trained at Trinity College, Dublin. He commenced his professional career in 1870 as an Assistant Surveyor in Co. Antrim. The following year he became Assistant Engineer to the Dublin Port and Docks Board, succeeding to the chief engineership in 1898, a position which he resigned in 1913. In 1919-20, he was President of the Institution of Civil Engineers, London. He had varied interests, and was the originator of the Liffey hydro-electric project. He served on the Royal Commission on Canals and Inland Waterways, advised the Government on the Harbours at Wicklow and Arklow, and with some colleagues was Consultant to the Mersey Docks and Harbour Board on the training walls in the outer Estuary of the Mersey. He was also a Commissioner of Irish Lights. A long, very useful and honourable career has been closed.

Centenary of Southampton Docks

Celebration of 100 Years of Progressive Expansion

The Unveiling Ceremony

A GRANITE column, surmounted by a globe, was unveiled at Southampton, on the 12th October last, by Mr. R. Holland-Martin, Chairman of the Southern Railway Company, as part of the celebrations commemorating the hundredth anniversary of the laying of the foundation stone of the Southampton Docks. The column, which is 8-ft. 6-in. high, and is surrounded by a bronze globe girdled by an equatorial band bearing the signs of the zodiac, bears the following inscription:—

1838-1938.

"On October 12, 1838, in the year of Queen Victoria's Coronation, the foundation stone of Southampton Docks was laid before a large assembly by Rear-Admiral Sir Lucius Curtis.

"On October 12, 1938, to commemorate 100 years of continuous development, this column was unveiled by Robert Holland-Martin, C.B., Chairman of the Southern Railway Company."

The unveiling ceremony was performed in the presence of over 350 guests of the Southern Railway Company, who afterwards inspected an interesting exhibition of pictures and models which had been arranged in connection with the centenary, and then were entertained at luncheon on board R.M.S. "Asturias."

In proposing the toast "Our Guests," Mr. Holland-Martin said that it was only a short time ago that the developments which had been carried out within recent years at Southampton seemed like a dream, and the dreamer was Sir Herbert Walker, the then general manager, who was now their colleague on the Board, whilst the engineer who had brought the scheme to fruition was Mr. Wentworth-Sheilds. The Chairman went on to refer to the various steamship lines which had been attracted to the port, and welcomed the representatives of these companies as well as the representatives of the trading community, the town of Southampton, the Harbour Board, the Chamber of Commerce and Trinity House.

In responding, Sir Charles C. Barrie, an M.P. for the borough and a director of the London and North Eastern Railway, referred to the close co-operation which was now maintained between the railway companies. The improvements which had taken place at Southampton were due, he said, to the energy and enterprise of the Southern Railway Company.

"The Southern Railway" was proposed by Mr. J. C. Patteson, European General Manager of the Canadian Pacific Railway, and Mr. G. S. Szlumper, General Manager, Southern Railway, and this year's President of the Institute of Transport, who, in responding, said that Southampton was one of the keystones of the fabric of the Southern Railway, the motto of which could be summed up in the expression: "Trade follows enterprise."

The Guildhall Speeches

In the evening the directors and principal officers of the Railway Company were the guests of the Corporation of Southampton at a banquet at the Guildhall, when the following telegram from Mr. Leslie Burgin, Minister of Transport, was read:—"All who have passed through Southampton Docks, both in times of peace and war, will share in the feelings of pride and pleasure felt by the directors, officers and staff of the Southern Railway on the occasion of the centenary of that great enterprise. The faith of the promoters has been abundantly justified by the proud position which the docks now occupy as the focal point of rail, sea and air transport. Please accept my heartiest congratulations and my best wishes for the future."

In the subsequent speeches, the Mayor proposed the toast to the Guests, and said how pleased he was to see so representative a gathering to do honour to the Southern Railway Company. Having recalled the early days of the London-Southampton railway—also within a few months of celebrating its 100th birthday—the Mayor remarked that unbelievable changes had taken place in the port. When the London and South Western Railway Company acquired the docks, the population of Southampton was 65,000, whereas to-day—46 years later—it was approximately 180,000. Throughout that period the Corporation and the Railway Company had worked in the closest harmony.

Proceeding, the Mayor said that in alluding to the docks there were men to whom he must refer. Sir Herbert Walker, who was General Manager of the Company for 25 years, was as great a friend to Southampton as the late Sir Charles Scotter had been. With regard to Docks Managers, some present would remember the late Mr. John Dixon, more would recall Mr. T. M. Williams, and practically everyone would recollect Mr. Gilbert S. Szlumper's association with the port. Mr. E. J. Missenden, too, made many friends during his short stay in Southampton, and Mr. Reginald Biddle, the present Docks and Marine Manager, was held in very high esteem. There were many other friends from Southern Railway headquarters, whom it was a pleasure to welcome that evening. In addition, there were Sir Sam Fay, Mr. F. E. Wentworth-Sheilds, Mr. J. M. Malerbi, Councillor R. N. Sinclair (the Sheriff-elect), and the representatives of Southampton Docks' staff and engineers.

Unveiling the Monument

Mr. R. Holland-Martin, who replied, said that the honour the town had done the Railway Company emphasised the close connection there had always been between the two. It was the intention of the Southern Railway further to cement that connection. He looked forward to a happy co-operation between them in the future. Southampton was a town of wonderful historic significance. It went back to almost the earliest years of English history, and in every age some great event had taken place there. It had such advantages that its citizens should see to it that they made the most of them. In the land reclaimed from the sea they had the possibility of great industrial expansion, which would assist the town, the docks and the railway. The Mayor had laid great stress on the services of those working for the company to-day, and he, too, would like to thank them—Mr. Biddle and Mr. McHaffie, and all their assistants, for the magnificent work they had put into the centenary celebration plans.

Mr. E. Gore-Browne, Deputy Chairman, Southern Railway Company, who also replied, said that the connection between the Company and the town was an extremely close one, and it became closer and more intimate as the years passed. It was the case of a main line railway and a great municipality working with a common purpose, and the more he looked back upon the connection, the more he had been impressed by how closely the interests intermingled. He had been impressed by the wisdom and courage of those who, 100 years ago, appreciated the advantages of Southampton Water with its double tides. Recalling the early incidents in connection with the Docks undertaking, Mr. Gore-Browne said the original scheme was first ridiculed. He wondered whether people thought very much the same when the Southern Railway decided to proceed with the Docks extension scheme. He was glad to think that among

Centenary of Southampton Docks—continued

those whose names would be added to those who would go down to history in connection with the scheme was the Southern Railway Company's Chairman, Mr. Holland-Martin, Sir Herbert Walker, Mr. Wentworth-Sheilds, Mr. McHaffie, Mr. Szlumper, Mr. Missenden, and Mr. Biddle, all of whom had been connected in one way or another with the development of that great enterprise. It had recently fallen to his lot, he continued, to carry out investigations of all the docks and ships owned by the Southern Railway, and he paid tribute to Mr. Biddle, Mr. Short and Captain Harvey and the members of their staffs. He went on to mention the great service which Southampton Docks were able to render to the community, and referred to the impressive figures in regard to the passage of troops and stores over the quays during the last war. In concluding, Mr. Gore-Browne said he had opened on the note that the town's interests and the Company's interests were closely interwoven, and in that connection it was interesting to reflect that in 1892, when the Railway took over the docks, the gross tonnage of shipping handled at the port was 2,250,000 tons, whereas in 1937 the total was only slightly less than 20,000,000 tons. Similarly, in 1839 the rateable value of Southampton was £87,000; to-day it was over £1,500,000.

The toast of "Our Hosts" was proposed by Mr. Gilbert S. Szlumper, who said that the invitation extended by the Mayor and Mayoress and townspeople of Southampton, made him and his colleagues realise afresh that the prosperity of both of them was closely interlocked. He remarked upon the helpful spirit inside the dock walls, and challenged anybody to find a more efficient and energetic body of workers. Concluding, he said: "I may say that you are assured of the co-operation of the Southern Railway Company in all your aims and efforts, and in conclusion, I desire to thank you for the manner in which you have marched hand-in-hand with us."

Replying to the toast, Alderman Sir Sidney Kimber, J.P., said that as long as the Corporation, the Harbour Board and the Southern Railway Company worked together as they had done for many years, then the future of the port was bound to be assured. "To those who come afterwards I will say that there is one thing that they must be careful about, and that is to see that from time to time every bit of the waterfront from Netley to Hythe must be brought in to become part and parcel of the Port of Southampton." Sir Sidney recalled the time when the Southern Railway had decided to build their docks extension on the Woolston side, and had bought the land for that purpose. The plans were out, but it was Mr. Gilbert Szlumper who said they should be on the Millbrook side, and he was right, for there the new docks were to-day. Now the Corporation had the option on that land bought by the Southern Railway at Woolston, and they would purchase it before the option expired, so that it would become part of Southampton for all time. Continuing, the speaker said they would remember with gratitude the years that Mr. Szlumper had spent at Southampton, and also recall the work of a previous Chairman of the Company, Sir Wynham Portal, who received the Freedom of the Borough in 1895 in recognition of his services in connection with the development and extension of Southampton Docks. Mentioning other servants of the Company who had attained high distinction, Sir Sidney said Mr. R. P. Biddle's training at Southampton had given him the opportunity of becoming a first-class manager, and in addition to the heads of departments, there was a very large number of men in the docks, both on the staff and working with their coats off, who were doing very good work on behalf of the Company. Sir Sidney wondered whether, without the great drive and energy of Sir Herbert Walker, backed up by the enthusiasm of Mr. Szlumper, the directors of the Company would have taken that great risk and invested £8,000,000 on the new docks. The Southern Railway brought an enormous amount of money to the town, if they took the weekly wages bill alone, and without the Company the port would have been very small indeed. Just as the municipality co-operated, so did the Harbour Board, whose constant care was to see that there was a fairway from the docks to the open sea, and this essential task was carried on no matter what the expense might be. In conclusion, Sir Sidney also referred to the great efforts made by Mr. Harry Parsons to bring Imperial Airways' flying-boats to Southampton. Their coming might or might not be to the advantage of the railway company in the future—no one could visualise what it might bring forth, but in that matter, too, there had been generous co-operation from the Company.

Early History of the Port

In one hundred years, Southampton has risen from a comparatively insignificant shipping centre to one of the most famous ports in the world.

On October 12th, 1838, the foundation stone of the first dock was laid in the presence of Civic officials and Masonic Brethren, by the Deputy Provincial Grand Master of Hampshire. To-day, Southampton is the premier ocean passenger port of Great Britain, and 32 shipping lines connect Southampton with more than 160 of the world's largest ports.

Actually, the town's maritime history dates from much earlier days. Two thousand years ago, the Romans established a port a mile or so upstream from the mouth of the Itchen, which they named Clausentum. A thousand years later, the Saxons selected the spit of land between the Itchen and the Test, where they built Hamtun, which became the site of the present town. As the years progressed, the town grew, and its importance as a port developed.

On August 16th, 1836, a group of business men from London, Liverpool, Manchester and Southampton, met in the "George and Vulture" Tavern, London, to consider developing the potentialities of the Port of Southampton, and two years later, the Southampton Dock Company was formed and a foundation stone was laid on 12th October, 1838.

From the outset, rail and water interests at Southampton were closely interwoven, the London and Southampton Railway being opened throughout in 1840.

Laying the Foundation Stone of the First Dock, October 12th, 1838 (after the painting by Ann Zinkeisen)

The first dock was originally called the North East Open Dock, but is now known as the Outer Dock, and to-day is used exclusively by the cross-Channel steamers of the Southern Railway. It was officially opened for traffic in 1843, although in the previous year, while still in an incomplete state, it accommodated shipping. The first two British shipping companies to use the port regularly were the P. & O. Steam Navigation Company and the Royal Mail Steam Packet Company.

It soon became evident that one dock was not sufficient, and a second (the Inner Dock) was put in hand. The construction of the Inner Dock and the decision of the P. & O. Company to transfer their ships from Southampton to London, brought about a crisis in the affairs of the Southampton Dock Company, and they approached the London and South Western Railway Company for a loan of £250,000, which was sanctioned by Parliament in 1886. With the funds thus provided, it was decided to construct the Empress Dock, which was opened by Queen Victoria on July 26th, 1890, and is the largest of the four basins on the Docks Estate.

With the opening of the Empress Dock, Southampton became the only port in Great Britain which vessels of the deepest draught could enter or leave at any state of the tide. In spite of the increased size of the modern vessels now in service, that distinction is still held to-day.

Progress under Railway Ownership

The opening of the Empress Dock did not afford the relief that had been anticipated, and the London and South Western Railway Company were again approached for further financial assistance. Negotiations were conducted for the purchase of the Dock Company by the London and South Western Railway Company. There were completed in February, 1891, and the necessary Bill was approved by Parliament in November, 1892.

Among the first works undertaken by the new owners was the construction of Berths Nos. 34 to 36. Originally known as the Prince of Wales Quays, they have since been renamed Itchen Quays. The Test Quays had been started in the 'eighties, but work upon them had progressed very slowly, and they were not completed until 1902.

The transfer of the White Star Line's New York service from Liverpool to Southampton in 1907 necessitated further dock accommodation, and the construction of another deep-water

Centenary of Southampton Docks—continued

basin was commenced, this being finally completed in 1911. The dock, intended primarily for the Liverpool company's vessels, was originally named the White Star Dock, but following the attraction to Southampton of other large liners, the name was altered, in 1922, to its present title, the Ocean Dock. It is at these quays that the world's largest liners arrive and depart on the North Atlantic services, among them being the " Queen Mary " and the "Aquitania."

There are now seven graving docks at Southampton, the first of which was opened in 1846. The seventh, which is the largest in the world, forms part of the new extension, and was completed in 1933, and opened by His late Majesty, after whom it was named. The " King George V " Dock has an overall length of 1,200-ft., an entrance width of 135-ft., and a depth of 50-ft. 6-in.

Mention has been made of the fact that the P. & O. and Royal Mail Steam Packet Companies were the first two steamship undertakings to use the newly-constructed docks, in 1840 and 1841 respectively. In September, 1843, the Post Office mail packet establishment was transferred from Falmouth to Southampton, the first shipment of mails being made by the R.M.S.P. Company's " Teviot," which embarked 56 bags for the West Indies.

The connection of Southampton with the North Atlantic trade dates back, at least, to the 17th century, when, according to the municipal archives, a contract was granted by the Government to an unnamed local shipowner for the carriage of mails to North America. In 1836, the British Queen Steam Navigation Company was formed to run a steamer service between England and the United States. The " British Queen," 2,016 tons, made her first voyage between London and New York in 1839. In 1847, the Ocean Steam Navigation Company was formed in New York, and the wooden paddle-steamers " Washington," " Hermann," " Franklin " and " Humboldt," were built. Starting in 1851, these vessels maintained for some years a regular fortnightly service between Southampton and New York.

The first Norddeutscher Lloyd vessel called in 1856 and, except for the period 1914-1918, the association has remained unbroken to the present day. This applies also to the Hamburg-American Line, whose connection dates from 1857.

The Union-Castle Company's association with Southampton dates from 1853, when the forerunner of one of the two constituent companies, the Union Steam Collier Company, was formed. In 1857 the undertaking was re-constituted as the Union Steam Ship Company, Limited, and on September 15th, 1857, the first sailing from Southampton to the Cape was made by the " Dane." From then onwards the connection between Southampton and South Africa has remained unbroken, and was strengthened in 1900, when the amalgamation between the Union and Castle Companies brought the Union-Castle Mail Steamship Company into existence.

The White Star Line transferred their New York service from Liverpool to Southampton in 1907, followed, in 1911, by the Cunard Line, whose vessel "Albania " called at Southampton on May 1st of that year, en route from London to Canada.

Eight years later, the Cunard Company transferred their express service to New York from Liverpool to Southampton, and the first journey was made by the "Aquitania " when she sailed from the docks on the 14th June, 1919, with about 5,000 Canadian troops. The famous " Maurentania " also sailed on the service later in the same month, and these two ships were joined afterwards by the " Berengaria."

Services in Time of War

Apart from its commercial activities, Southampton has occupied an important position in war, and in three campaigns its advantageous position has proved of value in the despatch of troops, munitions and stores overseas. On the outbreak of the Crimean War in 1854, a large number of the steamers using the port were requisitioned to convey troops, horses and supplies to the scene of activities.

The South African War of 1899-1902 also demonstrated the capabilities of the port, by the rapidity with which troops and material were despatched and landed, and during the Great War over 7,000,000 personnel, and 1,000,000 horses, guns and vehicles were dealt with, in addition to parcels, mail bags, stores and ammunition.

The Recent Extension

The opening of the " King George V " Graving Dock marked the completion of a great scheme of port extension. The bay between the Royal Pier and Millbrook Point, some two miles up the River Test, which at low tide was a waste of mud, has been reclaimed, work being commenced in 1927. The bed of the river was dredged to a depth sufficient for the deepest draught ships afloat, and the spoil thus obtained was transferred by suction pipe-lines to the area awaiting reclamation. This involved moving about 10 million tons of solid matter a distance of half a mile. In July, 1928, the construction of the new quay, 7,000-ft. in length, was begun.

The extension programme also included the erection of eight sheds for the embarkation and disembarkation of passengers and cargo, and the reclamation of the waste-land has provided a large area of land which is now available for the erection of factories, complete with rail, road and deep-water access.

Progress of the Foreign Trade Zone (Free Port) Principle

Address by Mr. THOS. E. LYONS,
Executive Secretary, United States Foreign-Trade Zones Board.*

The Pacific Coast Association of Port Authorities has honoured me by asking for a general report of the progress of the foreign-trade zone principle. You of the port and terminal profession are a wide-visioned group, albeit tempered by daily problems of stark reality. In few professions is the " sink or swim " alternative of such continuous importance. Adversities of man and nature have developed a fine spirit of courage within your ranks, and have kept you alert to the meaning of and necessity for progress.

Port authorities know that a port is simply a collection of terminals within a circumscribed area, and are aware that a foreign-trade zone is a terminal within a port, but incorporating certain features not ordinarily available. It is these features that have aroused the interest of port authorities who naturally are interested in any constructive idea or facility that promises port progress. Unfortunately, in some ports there is not the unity of services necessary to a terminal. The union of land and water carriers may not be complete, nor may the function of storage work in harmony with needs of the port. It is the endeavour of such associations as yours to aid in the solution of these problems and to observe progress made elsewhere in the efficient handling of merchandise.

World-wide Importance of Zones

It is hard to pick a sizable maritime section of the earth that does not contain facilities for the cheap and efficient storage and handling of foreign commerce. Where zones have not been established and where their need is felt, you may be sure of finding advocates of the principle that underlies zone establishment.

Even in these hard days of economic nationalism, the principle survives and the creation of zones continues. The principle survives because it is based on truth and no amount of opposition or lack of understanding can alter its existence. It will present itself at every opportunity, and by its application should prove wrong those who oppose it.

Two recent instances indicate the progress of the zone or free port principle. The Government of France, after many years of discussion, has passed a law similar to that in effect in this country. It is expected that a number of the important river and sea ports of France will establish customs-free zones under this law within the next few years. This right is extended to Algerian ports, which also have indicated a desire to create such zones in their modernised harbours.

In Genoa, where extensive new port construction has been undertaken, an area has been set aside and plans have been completed for the segregation of a zone to be operated on the same principle as are the present free ports of Trieste and Fiume. A royal decree to this effect was published last March, and operation awaits completion of the necessary facilities.

In Cuba, at the Port of Matanzas, are being created the facilities of a foreign trade zone. Rules and regulations have been promulgated, and it is expected that the zone will be in operation shortly. It promises to relieve the over-crowded harbour facilities of Havana and to bring new business to the Island of Cuba.

The Two Applications of the Zone Principle

You, of course, are familiar with the principle upon which zone establishment is justified: That until merchandise enters the country of consumption, it should be free. The re-state the principle the other way round, no country should restrict the freedom of merchandise which has not applied for customs entry.

In application, the term "merchandise" is restricted to those lawful commodities of peaceful trade; and the term " free " indicates freedom from all duties and taxes of whatever nature, and freedom, within reason, from customs and other govern-

* At the Twenty-Fifth Annual Convention of the Pacific Coast Association of Port Authorities, Portland, Oregon, August 17th, 1938.

Progress of the Foreign Trade Zone (Free Port) Principle—continued

mental regulations not necessary for the protection of the revenue, public health or safety.

A country having a high tariff imposes, proportionately, more restrictions on foreign commerce than a low tariff country, and thus has a greater need for a neutral vestibule at major ports to care for those products which are destined to a third country, or which are not prepared for entry into the country at the time of arrival.

Merchandise in transit, merchandise for transhipment, foreign merchandise for export—these are the commodities which welcome the freedom of the foreign-trade zone. In 1937 more than 253 million dollars worth of these products passed through our ports, and these products, by every right, were entitled to freedom from all duties and taxes of whatever nature. It is a purpose of foreign-trade zones to make available to these transit goods the freedom they require.

Another group of foreign merchandise is attracted naturally to the foreign-trade zone; this group is intended for eventual consumption, but at the time of importation requires conditioning or storage before entry. The potentialities are indicated by the fact that in 1937 nearly 470 million dollars worth of this type was thus classified for warehouse entry.

There is a third group of foreign commodities, nebulous, at the present time, but capable of almost unlimited expansion. This group is composed of new products, and products which bring new business to the country. By reason of favourable circumstances, not the least of which is a minimum of customs expense and regulation, the great ports of Europe have become world markets for many commodities. Liverpool for grain, London for wines and spirits, Bremen for cotton and coffee, Amsterdam for rice, etc., for a long list of ports and commodities. It is not unreasonable to foresee a shift of some of these markets to an American foreign-trade zone in the near future. I am sure that when the possibilities of foreign-trade zones are fully understood by all, and when research has been undertaken, this group will overshadow all others in taking advantage of zone opportunities.

Zone Progress Abroad

Observation of how this principle is faring in other countries shows how consistently the customs-free zone is the method adopted as the most satisfactory. In Europe—Latvia, Poland, the Free City of Danzig, Sweden, Denmark, Germany, Switzerland, Czechoslovakia, Yugoslavia, Spain, Italy, Greece, and now France, have adopted the customs-free zone. Most of the colonial possessions of these countries also enjoy a similar status. In Asia—Siberia, Manchuria, Hong Kong, Singapore, Portuguese and French India are a few territories having some form of customs-free area. In Latin America—Mexico, Curacao, Tierra del Fuego and Uruguay have zones or territories exercising the principle. Several other countries in Latin America have under construction or consideration free zones, among which may be mentioned Cuba, Venezuela, Colombia, Brazil, Argentina, Paraguay, and Bolivia.

Where there exists economic justification for these zones, that is, where world trade passes through ports for conditioning and distribution, generally will be found successful and progressive free zones in such ports. In Sweden, the free port at Stockholm handled 490,000 metric tons of cargo in 1937, a 33 per cent. increase over 1936; the free port at Gothenburg, also in Sweden, was visited by 5,772 vessels with a net tonnage of 4,043,000 tons, which was approximately half of all vessels engaged in foreign traffic entering Gothenburg during 1937.

At the new Polish Port of Gdynia the total merchandise traffic for 1937 was 9,147,000 metric tons, an increase of 16 per cent. over 1936. Of this traffic, overseas imports increased by 28 per cent., in which the well-equipped free zone had a very considerable share. Incidentally, the free zone at Gdynia has become an important arbitrage point for cotton, hides and skins, and coffee.

The Greek free zone at Salonika is strategically placed, both for traffic from the Mediterranean to the Black Sea, and as an Aegean outlet for the Balkan countries. Since its creation in 1925, the zone's importance has increased from practically nothing to the handling of 397,000 tons of imports and 375,000 tons of exports last year.

Similar progressive statistics could be quoted for Hamburg and for Copenhagen, for Trieste and for Alexandria, Egypt, but this report would gain little by their addition, other than to show that free zones can be a useful and successful adjunct to the facilities of many ports.

Zone Progress in the United States

Turning our attention from foreign free ports to the progress made by the free port principle in America, we find every indication to encourage our faith in this principle.

Mobile, an alert and increasingly important Gulf port, qualified for, and was awarded a Federal grant to establish a foreign-trade zone. After ten months of preparation, the zone was opened on the 21st of last month. While it is yet too early to report, there seems to be a number of favourable indications for the success of the zone. Chief of these indications is the general awakening of interest in the port since Alabama applied for the grant late in 1935. The economic survey required for the proposed zone indicated the possibility of additional industries and increased commerce for the port. That the Port of Mobile has taken full advantage of the information developed in the survey and the stimulus resulting from it is shown by the 1937 figures. In 1937 the port had increased its water-borne tonnage over 1935 by 35 per cent., and the value of its foreign trade by 60 per cent. Since 1935, there have been attracted to Mobile a sizeable number of major industries that will further increase port and city prospects.

San Francisco has applied to the Board for a grant to establish a zone. Pending San Francisco's determination of a suitable site that can be properly segregated, the Board has not taken final action to bring a zone to the Pacific Coast.

San Juan, Puerto Rico's principal city and port, also has filed an application with the Board. Progress has not yet reached the stage of a hearing, but there is evidence of increasing interest there in supplying the Board with necessary data for final action.

The New York Zone

New York, which established the first zone in this country, is encouraged in the knowledge that shippers and manufacturers throughout the world are taking an interest in the zone. Despite the handicaps under which the City of New York struggled in the early operation of the zone, a very creditable showing was made during the last full month of the Dock Department's operation, April, 1938. On April 30th, the approximate value of goods on hand was $764,781. During the month of April the approximate value of merchandise received and delivered by the zone was $258,716, representing a modest tonnage of more than 512. There were 20 kinds of merchandise owned by 19 customers who had imported from 15 countries and re-exported to three foreign countries. During the same month of April, the Customs revenue to the Government was more than $12,000. As encouraging as the figures are, listen to comparative figures for June, only two months later!

The approximate value of goods on hand, June 30th was $1,800,000, an increase of 136 per cent. During the month the approximate value of merchandise received and delivered by the zone was $694,744, an increase of 168 per cent., and an increase in tonnage handled from 512 to 4,461, or 770 per cent. The Customs revenue to the Government was over $19,000, or 52 per cent. greater than in April. Should these rates of increase continue, the New York Zone will need greatly enlarged facilities by this time next year.

Recently, Mr. Newbold Morris, President of the City Council of New York, made the following remarks concerning the activities of the zone during June: "On a typical day, 214 workers were employed in the zone. During the month 62 lighters and 8 steamers called there. Twenty-five customers were using the zone facilities for 74 different kinds of merchandise, including balsam, Brazil nuts, coal tar colour, cocoa beans, cod liver oil, electrical apparatus, leather, linen, mica, rugs, straw hats, tapioca flour, and tobacco."

It is interesting to study the commodities which have been attracted to the zone in New York and in what manner they are making use of zone facilities. Selecting a few major commodities from among those now in the zone, it is found that 22,378 cases of Argentine corned and roast beef are being unpacked from heavy wooden cases, relabelled upon order of various wholesale distributors in this country and re-packed in small, light cardboard cartons of American manufacture. As each order is filled, duty is paid and the canned beef shipped out for consumption.

From Italy and Belgium have come 4,100 bales of cotton and jute rugs. The importer stores them in the zone where they may be examined by prospective purchasers, and as he finds buyers the importer pays the duty on the rugs when they are sold and delivered. A substantial amount of money is saved from being tied up in duty on unsold rugs. So successful is this new method of selling rugs, that the importer has transferred his offices to the zone, and now maintains only a small sales office in Manhattan. The importer's unqualified approval has interested other rug importers, and is an indication that the zone may become the focal point of rug storage and distribution.

How zone facilities may prevent an innocent importer from loss is pointed out in the importation of 3,813 barrels of cod liver oil into the zone. Under our Tariff Act, cod liver oil is duty-free, but the Department of Agriculture imposes a severe penalty if the product is not what is claimed or does not come up to the U.S.P. standards. The importer of this product took the precaution of having Agricultural inspection of his oil in the zone prior to entry. He found the oil to be that of another fish, not cod, and is in the position of being able to return the

Progress of the Foreign Trade Zone (Free Port) Principle—continued

oil without loss or to enter it under its proper name, without penalty.

The Scot will not be alone in appreciating the thriftiness of several nut importers that have some 4,000 tons of Brazil nuts ripening at the zone. The drying of these nuts in the zone is saving the importers approximately $3.36 a ton in duty, which would otherwise have been paid on the weight of moisture had the nuts been entered into Customs territory upon arrival. An appreciable tonnage is being sacked and re-exported for the Australian market.

It does not take a prophet to see the future pointed out by the importer of 39 hogsheads of South African brandy. Brandy from South Africa is unknown in this country, and the zone has encouraged its introduction. This spirit is 114 proof upon arrival in casks, but by proper dilution and marrying in a huge vat constructed for the purpose, the brandy is brought down to 86 proof, and duty is paid on the lower figure (such duty is assessed on a minimum of 100 proof). In addition, a bottling company has taken up quarters within the zone and will bottle and case brandy ready for re-export or domestic distribution. The importer, the bottler, the labour and the containers are all American. Is it difficult to vision imported whisky, brandy and wines being bottled at the zone from huge casks at great savings in freight and material costs?

A final example of zone convenience is represented by the storing of 500 bales of very expensive Sumatran leaf tobacco in the zone. The tobacco is dutiable at $1.50 a pound. By storing this tobacco in the cool atmosphere of the zone, not only does the importer keep his capital from being tied up in duties or bond premiums, but he takes advantage of the ideal storage conditions of the zone for his product.

I have named but six of the commodities that have made use of the zone since its inception. Daily the list is being expanded. The process resembles a snowball rolling down hill, and may the slope be long! Chemicals, hides and skins, machinery, textiles, photographic materials, minerals, household effects of German refugees, foodstuffs, these and many more are passing through the zone, attracted by the promise that until and unless they are ready for customs entry they remain as free products. Free from Customs duties, free from excise, free from penalties and free from formal regulations affecting ordinary importations. With the knowledge that this freedom is available, the demand for zones and zone accommodations will invite prosperity to ports and to the sections they serve.

Transference of a Dock Passage Bridge

A Skilful and Ingenious Operation at Liverpool

(CONTRIBUTED)

The construction of a new River Entrance Lock at Liverpool, designed to facilitate the docking of the largest class of modern coastwise vessels at all states of the tides, has necessitated the demolition of an existing passage between West Waterloo and Trafalgar Docks, and the substitution of a new passage, in a position about 500-ft. to the Northward, between Trafalgar and Victoria Docks. A description of this undertaking can be found in the issue of this Journal for September, 1937.

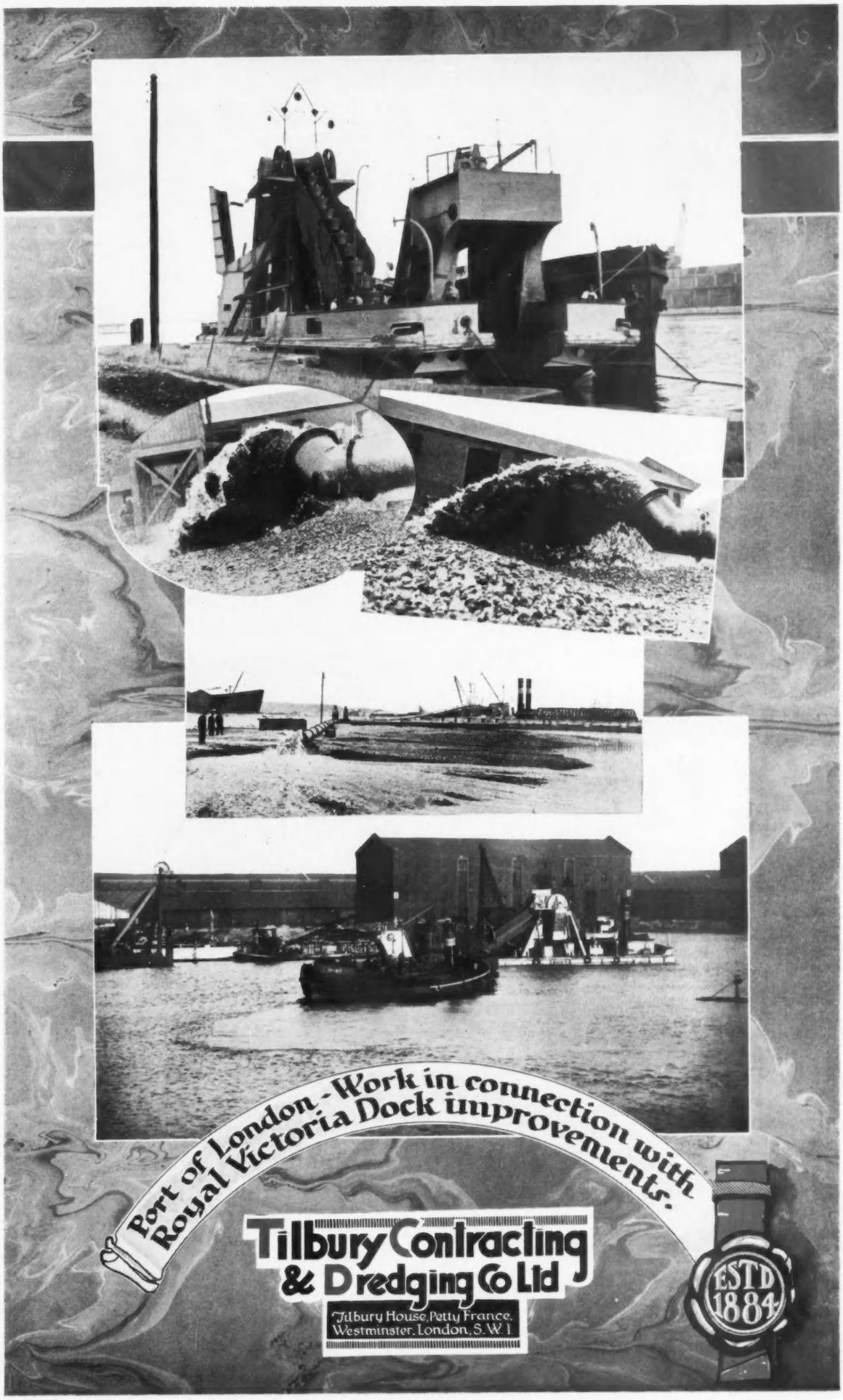
A contingent work of much interest has been the transference of a ponderous rolling lift bridge from one passage to the other. Several modes of effecting this were devised and considered by the Board's Engineer-in-Chief, Mr. T. L. Norfolk, M.Inst.C.E., who ultimately decided upon conveyance by flotation of the bridge structure as a whole.

The weight of the bridge, including ballast, is 660 tons, and the centre of gravity of such a bridge is, of course, vertically above the point of contact between the quadrant of the bridge and the track on which the bridge rolls.

Removal beforehand of the heavy quadrant bearing plates and the whole of the concrete ballast in the counterbalancing arms, reduced the weight to be transported to about 300 tons, and shifted the centre of gravity of the mass a considerable distance along the bridge towards its nose end. The length of the bridge was such that by means of slides, hydraulic jacks and a number of other temporary devices, the centre of mass could be moved forward, while the bridge remained in its closed or horizontal position, to a point favourable for the reception of the load upon a pair of barges, normally used in salvage operations, securely lashed together. The barges, water ballasted to sail under the bridge, were then brought into a predetermined position, wherein, under the full load they would remain in perfect trim. Removal by pumping of part of the water ballast had to be knowledgably supervised to lift the barges into touch-contact with the bridge and raise it clear of its bearings on both pierheads. Barges and load were then warped across the dock from the old position to the new, as shown in the photograph. There remained only the operation of sinking and withdrawing the barges.

Bridge being floated to new position

The operations were carried out with perfect smoothness in 5½ hours, and technical readers will be duly impressed more by the merit of the preparatory work than by the spectacular features.


Port of London - Work in connection with Royal Victoria Dock improvements.
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Registered KINNEAR Trade Mark

Leith Dock and Harbour Commission.

Kinnear Shutter in Passageway connecting old and new Grain Warehouses, photographed after Fire referred to in accompanying facsimile letter. One of 97 Kinnear Shutters in use at these Docks.

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ALFRED H. ROBERTS M.Inst.C.E. SUPERINTENDENT & ENGINEER

Dock Offices, Town Place, Leith 20th May, 1930.

Messrs. Arthur L. Gibson & Co. Ltd., 121, West George Street, GLASGOW.

Dear Sirs,

Fire at Old Grain Elevator Warehouse, Leith. Kinnear Shutters.

With reference to the recent fire at the Grain Elevator Warehouse at Leith Docks, when the Old Warehouse was totally destroyed, it will interest you to know that the Kinnear Shutter which was placed in the centre of the Covered-way between the Old and New Buildings proved of great service and certainly prevented the fire from spreading to the New Building.

Some of the burning grain and timber lodged in this Covered-way and was burning for at least two weeks before it was ultimately extinguished and during this time the doorway was subjected to very great heat, so much so that part of it was red hot for a considerable period. The fire in this part of the Covered-way was ultimately extinguished by breaking through the concrete floor above and so getting the hoses to work directly down on to the burning material. After the burnt material was cleared away it was found that the door was still in working condition and although a little stiff at first we were able to raise it and it is still in use no repairs having been required.

This Shutter was put in as a fire preventive measure and we were glad to find that it was satisfactory under very trying conditions.

Yours faithfully,

Alfred H. Roberts

Superintendent.

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WRITE FOR CATALOGUE L3.

PORT OF LIMERICK.

ENGINEER TO THE LIMERICK HARBOUR COMMISSIONERS;- T.F. SULLIVAN Esq., B.E.

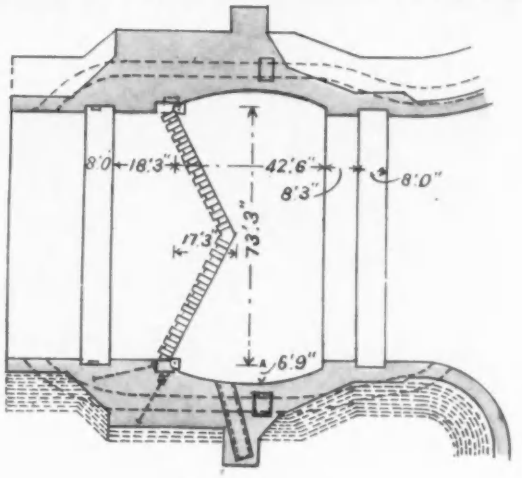
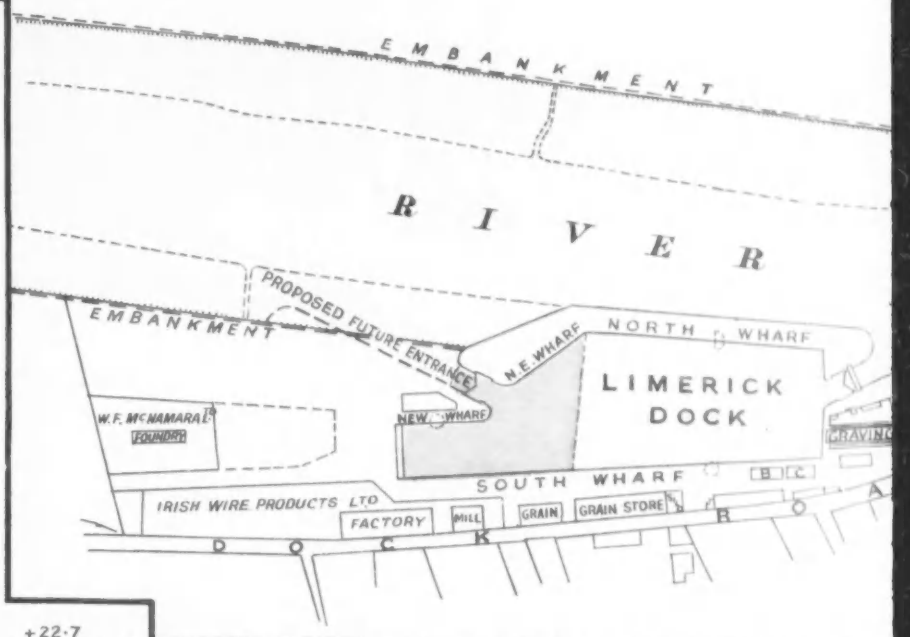
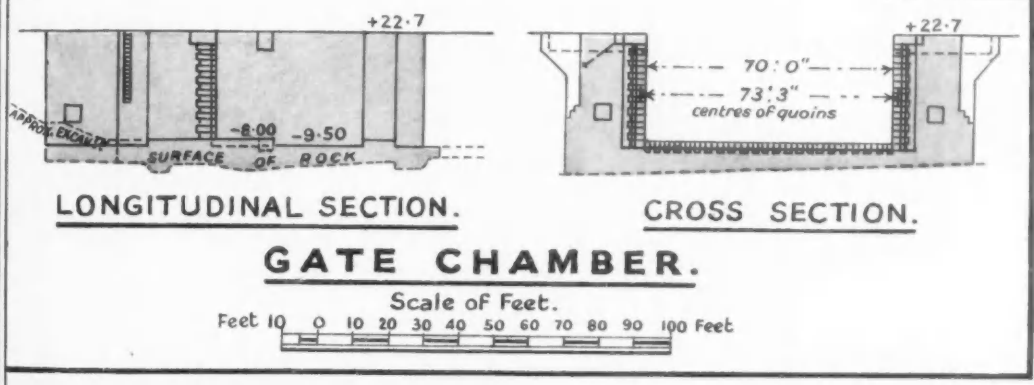


FIG. 4. PLAN.





GATE CHAMBER.

Scale of Feet.

Feet 10 0 10 20 30 40 50 60 70 80 90 100 Feet

FIG. 2.

OLD DOCK WALL

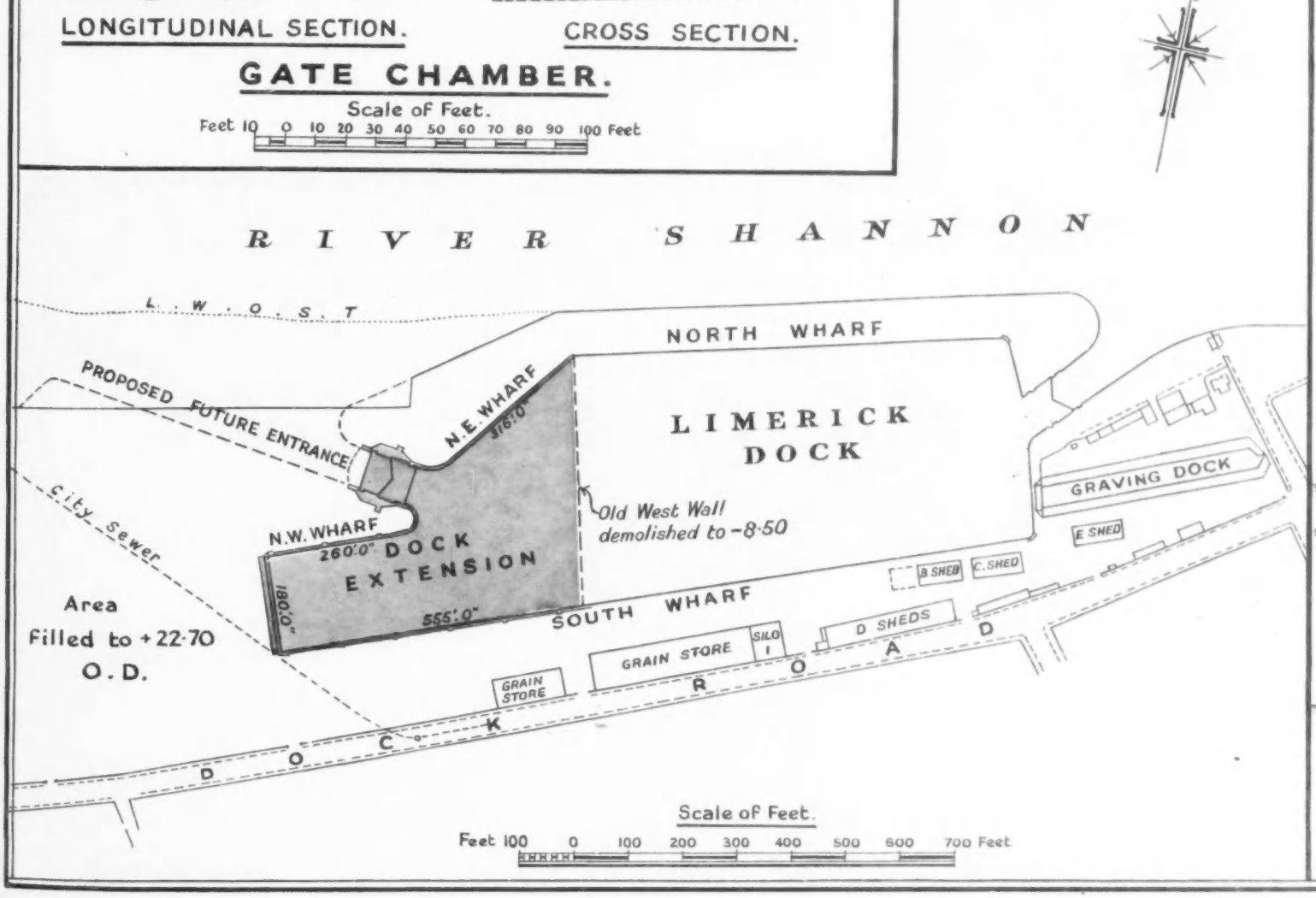
On Rock or Boulder C

(Built 1849)

FIG. 3.

SOUTH WHAR

On Rock



WARD & FOXLOW, LITH., HARCOURT STREET, MARYLEBONE W.

ERICK.

NERS;- T.F. SULLIVAN Esq., B.E.

FIG. 1.

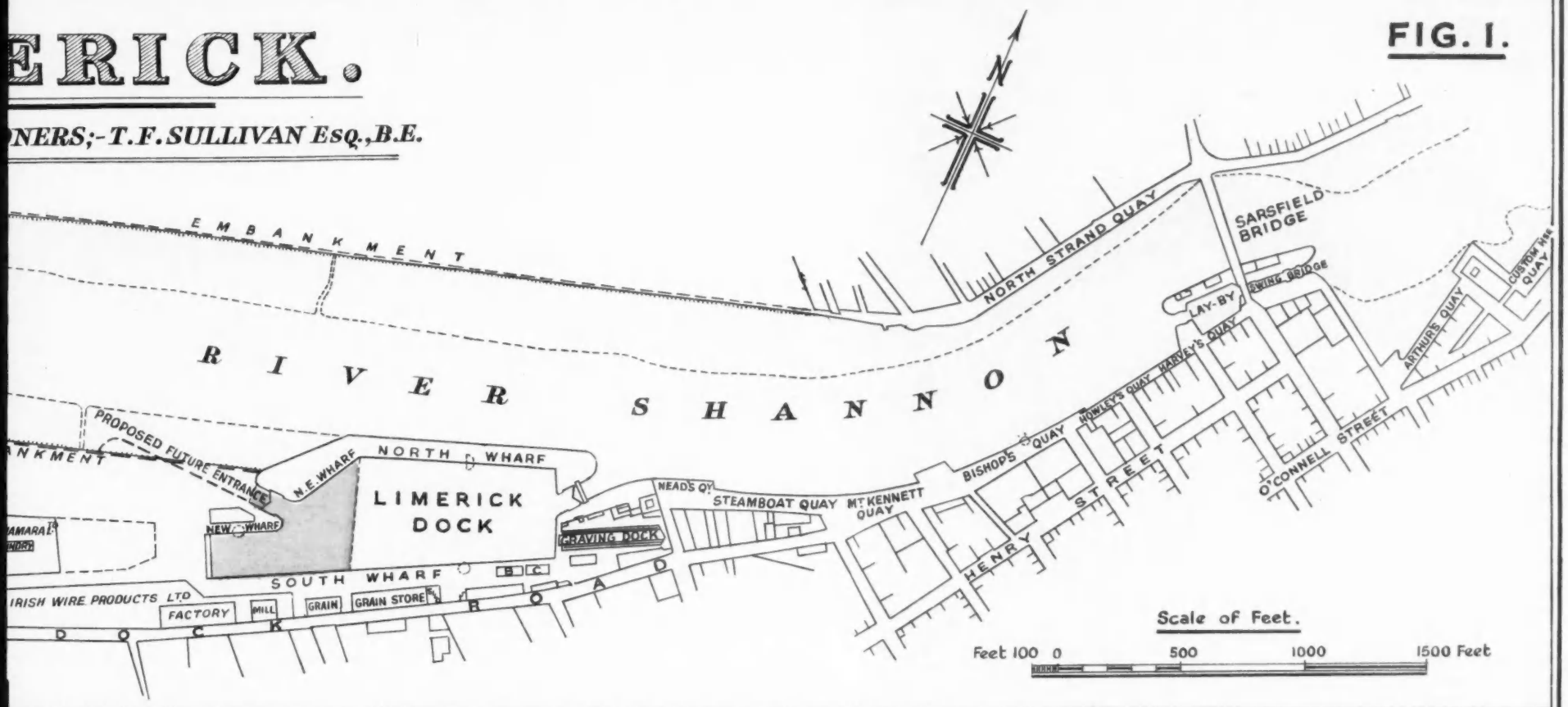
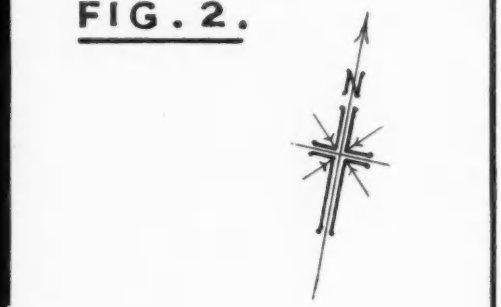
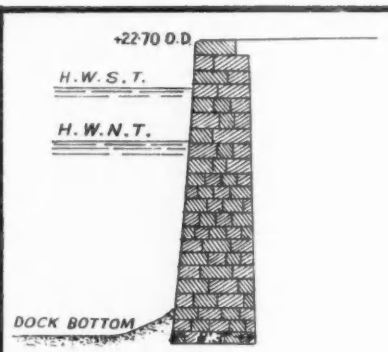
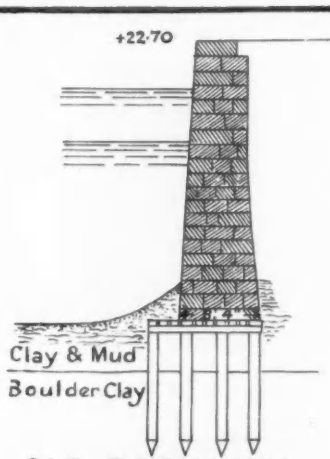


FIG. 2.

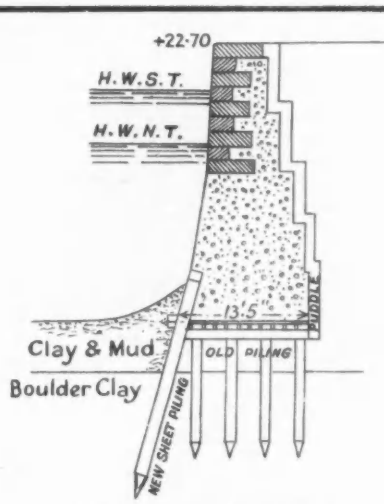




OLD DOCK WALL.
On Rock or Boulder Clay.
(Built 1849)



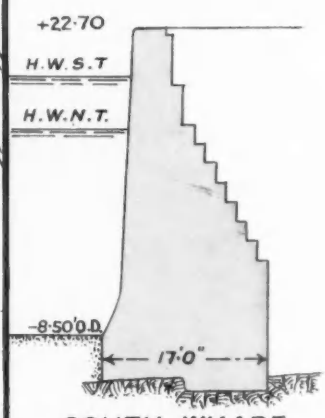
OLD DOCK WALL.
On Piling - (Built 1849)



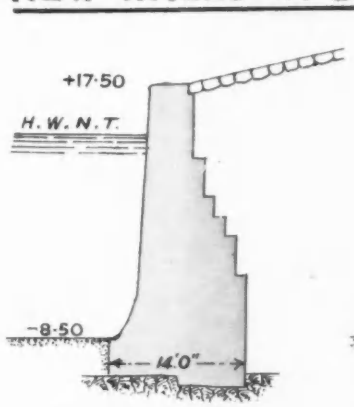
NORTH WHARF.
(As Rebuilt 1888)

FIG. 3.

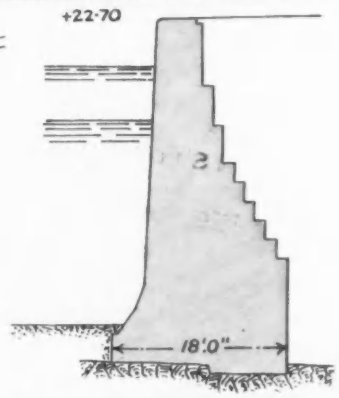
NEW WALLS IN DOCK EXTENSION.



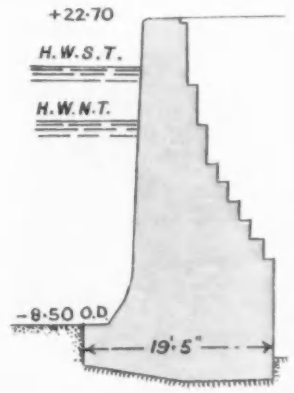
SOUTH WHARF
On Rock



WEST WHARF
On Rock



NORTH WEST WHARF
On Rock



NORTH EAST WHARF
On Boulder Clay.

Scale of Feet
Feet 10 0 10 20 30 Feet

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Larssen Piling, Section No. 3, rolled from high-tensile rust-resisting steel, interlocked prior to being driven with a No. 9B2 McKiernan-Terry hammer, for the reconstruction of a quay wall at Fleetwood.

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Clyde Navigation Trust.
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Dublin Port & Docks Board.
Egyptian Ports and Lights Commissioners.
Fremantle Harbour Trust.
Gothenburg Harbour Board.
Greymouth Harbour Board, N.Z.
Humber Conservancy Board.
Melbourne Harbour Trust.
Mersey Harbour Board.
Ministerio Obras Publicas, Venezuela.
Ponts et Chaussees, France.
Port of London Authority.
Portos e Navegacao, Brasil.
Rangoon Port Commissioners.
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Singapore Harbour Board.
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By Lieut.-Commdr. D. H. MACMILLAN, R.N.R. (Retd.) Extra-Master Mariner, A.I.N.A.

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Notes of the Month

Floating Dock for Fremantle.

A proposal has been mooted for the transfer of the floating dock from Newcastle, New South Wales, to Fremantle. The State Government has the matter under consideration.

Coleraine Harbour Dredging.

The Coleraine Harbour Board, at a recent meeting, accepted the tender of Messrs. Harbour and General Works, Ltd., for dredging the river channel and approaches to the harbour at a cost of £8,858.

North Shields Pontoon Dock Removed.

Smith's Dock Company's No. 8 (Pontoon) Dock, North Shields, which has been in use since 1892, and accommodated over 2,700 vessels, was, during the course of last month, towed to Gateshead to be broken up.

Superannuation Scheme for Aberdeen Harbour Commission.

At a recent meeting of Aberdeen Harbour Commissioners, it was agreed to adopt a superannuation scheme for the employees of the Commissioners, and the necessary steps are to be taken to obtain Parliamentary powers to give effect to the scheme, which, it is estimated, will cost £3,536.

Jetties to be Constructed at Shatt-al-Arab.

It is reported that a Swedish Company have secured a contract from the Iranian Government for the construction of jetties on the left bank of the Shatt-al-Arab, about one mile above the mouth of River Karun. The jetties are intended for the discharge and loading of cargoes by ocean-going vessels.

New Oil Wharf for Bombay.

The Bombay Port trust have decided to build a new pier by extending the wharf at Timber Pond. The new pier, which will be 60-ft. wide and 450-ft. long, is close to the petrol and kerosene storage tanks at Wadala and Sewree, and is estimated to cost 1,75,000 rs. It will serve as a berthing and loading place for the large number of country craft which trade in kerosene and petrol with ports on the west coast.

Tanker's Rapid Discharge.

The motor tanker, "Athelregent," recently docked at Liverpool with 12,730 tons of bulk molasses, and discharged her cargo through underground pipes leading from her berth in Huskisson Dock to big new tanks adjacent to the dock, this being the first time the new tanks were used. She commenced discharging at 8.30 a.m. on the 10th October and finished at 4.30 p.m. on the 12th, a total of 44 hours.

Mill and Warehouse for Limerick Docks.

A contract for building a mill and warehouse at Limerick Docks has been placed by Messrs. Rank (Ireland), Ltd. The buildings will each be 200-ft. long, 100-ft. wide and 100-ft. high, and the total cost is expected to be about £200,000. The warehouse, which will be adjacent to the mill, will have nine floors, and will be built of mass concrete with steel girders. The work will take two years to complete, and is to be put in hand immediately.

Additional Grain Silos for Roumania.

In accordance with the decision of the Roumanian Government to erect a number of new grain silos throughout the country, the Ports and Waterways Department of the Ministry of Marine and Air are to build 80 silos with a total capacity of 450,000 tons. This new storage capacity is in addition to the existing silos at Braila, Galatz and Constantza, the total capacities of which amount to 140,000 tons. It is understood that the building of the silos is to be put in hand immediately, with a view to having about 200,000 tons extra storage space ready for the 1939 harvest. It is hoped that the remaining silos will be completed by 1940.

Port of Klaipeda (Memel).

According to the annual report of the Klaipeda (Memel) Harbour Board for the year 1937, the total arrivals in the port amounted to 1,414 sea-going vessels of 844,661 net registered tons, and 2,894 river craft and lake steamers with a tonnage of 156,726 net registered tons. Including goods in transit, imports totalled 1,108,418 tons, and exports amounted to 631,161 tons. The figures for 1937 show an increase of 2.7 per cent. above the previous year, and are almost three times higher than those of 1924. The total expenditure of the port in 1937 amounted to 3,079,688 Litas, of which 1,451,669 Litas were ordinary and 1,627,999 Litas extraordinary expenses. The income totalled 1,505,642 Litas, leaving a deficit of 1,574,025 Litas, which is covered by the Lithuanian Government.

Plan for New Dry Dock at Cardiff.

A plan to build a large public dry dock at Cardiff is under consideration by Cardiff Corporation, and a sub-committee has been set up to discuss the project with the Great Western Railway Company.

Maryport Docks Closed.

Maryport docks and harbour have been temporarily closed, recent storms having made the entrance channel unsafe. It is possible that they will remain closed until the Government grant and loan, totalling £75,000, for necessary dredging can be obtained.

Extensions at the Port of Stockholm.

The Port of Stockholm Authority has approved plans for the expansion and improvement of the port. The scheme, which is expected to involve the expenditure of a total of 2,900,000 kr., includes the re-conditioning of quays at a cost of 1,065,000 kr., the construction of new railway tracks at a cost of 850,000 kr., and the provision of new cranage equipment at a cost of 765,000 kr.

Channel Improvement at Wilmington.

Projects, estimated to cost $675,000, have received the approval of the United States War Department for the improvement of entrance channels to the Port of Wilmington, North Carolina. The programme includes the widening of the river channel to a width of 400-ft., from the inner end of the ocean bar at Southport to Wilmington; the enlargement of the ship-turning basin at Wilmington from 600-ft. to 800-ft., with a depth of 30-ft.; and the formation of a channel 100-ft. wide and 12-ft. deep from the eastern entrance of the Intracoastal Waterway to a connection about three miles upstream with the main river channel.

Retirement of Dover Harbour Master.

The retirement is announced of Captain John Iron, O.B.E., Harbour Master at Dover, after 40 years' service in that position. During his period of office he successfully carried out a number of salvage operations on vessels which had sunk in the harbour and navigable fairway. It is noteworthy that Captain Iron's father and grandfather both held the appointment, the former for 22 years, and the latter for 20 years. During the Great War, Captain Iron acted as Admiralty Salvage Officer in connection with the Dover Patrol.

Free Port in Newfoundland.

The Newfoundland Legislature has approved the creation of a free port at Mortier Bay, and a concession has been granted to the Great Lakes Newfoundland Atlantic Co., Ltd., for the purpose of establishing a free port there on similar lines to those at Hamburg and Copenhagen, in connection with the transhipment of goods between the Great Lakes, Europe, the West Indies and the Atlantic seaboard of North and South America, and to convey from the port to the Great Lakes chilled, frozen and cured fish and other products of Newfoundland.

St. Lawrence Ship Channel Increased Depth.

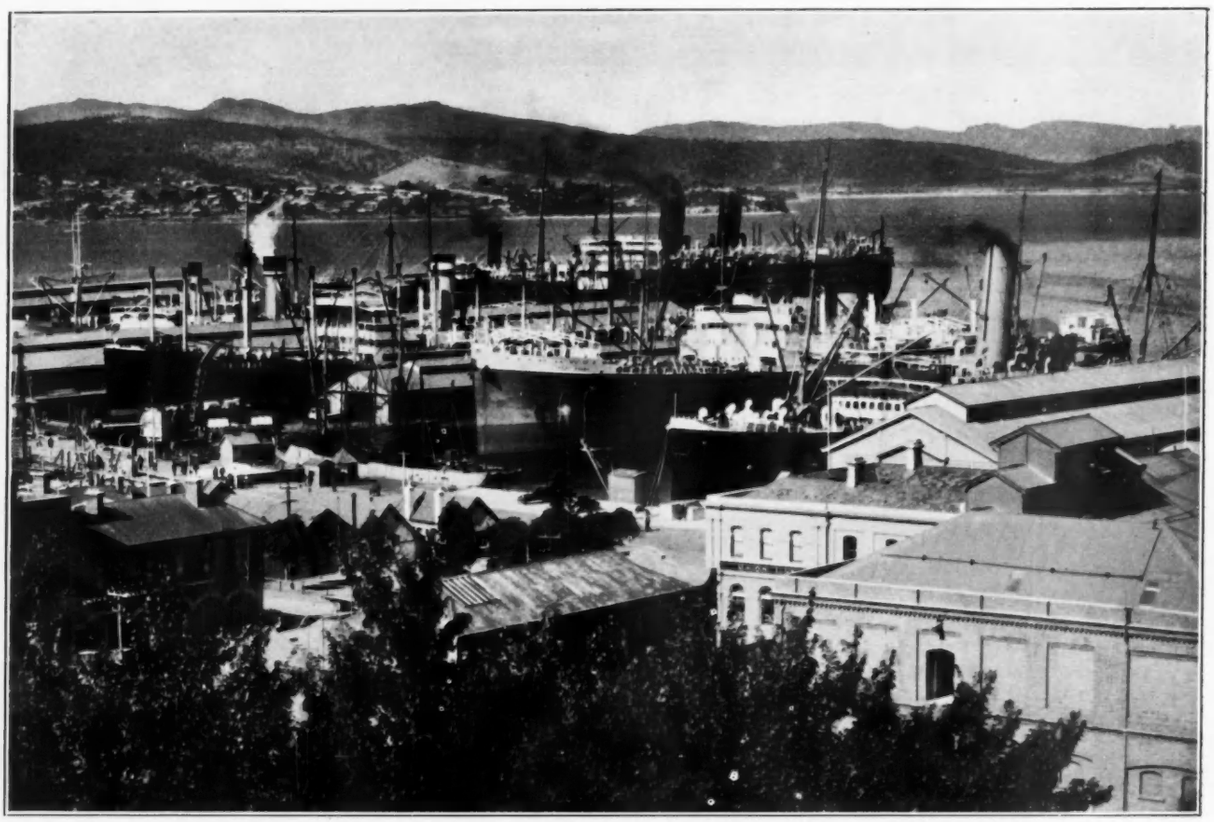
The Canadian Department of Transport announced at the beginning of October that there is now a clear depth of 32-ft. 6-in. in the St. Lawrence ship channel between Montreal and Quebec. This depth is based on the extreme low-water level mark of 1897, the datum now in effect. Previously, the channel had a depth of 30-ft. over the 1897 datum. The increased depth is the result of an extensive dredging programme which has been carried out in the St. Lawrence ship channel in recent years, and the work is now almost completed. Some spots still remain to be cleared, however, and a certain amount of sweeping work must be finished before the Government is able to authorise the full depth.

New York Harbour Proposed Improvements and Construction Work.

Plans and estimates for improvements to be made to piers at the foreign trade zone, Staten Island, and in South Brooklyn, have been submitted to the City Planning Commission of New York. The proposed improvements of the foreign trade zone are to piers 11 and 17, the original estimate for this being $2,230,000. The sum of $3,500,000 would be required for warehouse construction. The reconstruction of South Brooklyn piers between Thirtieth and Thirty-first Streets is estimated to cost $250,000. Other plans submitted include the improvement at lay-up slips and repairs to docks at St. George, Staten Island, at an estimated cost of $250,000, and the construction of a new bulkhead at the foot of Atlantic Avenue at a cost of $100,000.

The Port of Hobart, Tasmania

By ERIC HAWSON, Secretary of the Marine Board, Hobart.



A busy section of Hobart Harbour

Historical

THE Island of Van Diemen's Land (now Tasmania) was discovered by Abel Janzon Tasman on the 24th November, 1642, while on a voyage in the vessels "Heemskirk" and "Zeehan." It is recorded that Tasman's carpenter swam ashore near Cape Paul Lamonon on Forestiers Peninsula, East Coast, and planted the Dutch flag there, thus taking possession on behalf of his Government. Some hundred and thirty years later (1772) the French Navigator Marion du Fresne anchored his ships "Mascarin" and "Castries" in Marion Bay, and in the following year Capt. Tobias Furneaux visited Adventure Bay in the ship "Adventure." Amongst other notable visits in the eighteenth century were those of Capt. Bligh in the "Bounty," on his way to Tahiti, who landed and spent 12 days at Adventure Bay (this was, of course, before the mutiny of the crew); Capt. Cook, Rear Admiral Bruny D'Entrecasteaux and Capt. Huon Kermadac, Capt. John Hayes, Lieut. Flinders and Commodore Baudin, but it was not until 1803 that the first real settlement was made when, on the 11th September of that year, Lieut. John Bowen arrived at Risdon (about three miles above Hobart) in the ship "Albion." Governor Collins arrived at Risdon on the 15th February, 1804, and used judgment in transferring the settlement to the site on which the City of Hobart now stands, naming the harbour Sullivan Cove and the settlement Hobart Town. In the early years of the settlement progress was very slow, and it was not until a number of years later that any appreciable advance was made.

Port Administration

Following this brief reference to the discovery and first settlement of Tasmania, it is now open to give attention to the chief object of this article, namely, the Port of Hobart. Previous to 1858, the administration of the port duties for the whole island was in the hands of the port officer, but in the year mentioned, two guilds were formed to attend to maritime interests, such guilds being named the Hobart Town Marine Board and Launceston Marine Board respectively.

On January 8th, 1858, His Excellency Sir Edward Fox Young issued a proclamation establishing these guilds. The jurisdiction of the Hobart Marine Board was Cape Portland, at the extreme north-east of the island, round the east, south, and west coasts, to the 42nd degree of latitude, and one nautical league to seaward from low-water mark. In 1867 an Act was passed, giving the Governor-in-Council power to create other Marine Boards within the jurisdiction of the Launceston Board, but the limits of the jurisdiction of the Hobart Board were not altered till 1892, when a proclamation was issued by His Excellency the Governor, Sir Robert Hamilton, creating the Marine Board of Strahan, by which the Hobart Board's control was restricted to the coastline between Cape Portland and the South-West Cape, and one nautical league to seaward, and the control of Macquarie Harbour, on the West Coast, with adjacent waters, given to the Strahan Board. With regard to its constitution, the first Hobart Board consisted of five members—three appointed by the Governor-in-Council, and the Mayor of Hobart and the Collector of Customs as members ex officio. In 1874 this was altered as follows:—Two to be appointed by the Governor-in-Council, and three to be nominated by the Chamber of Commerce, with the Mayor, Collector of Customs, and Chairman of the Chamber of Commerce, as members ex officio. A change was made in 1889, when the elective system was introduced, and this system is in force at the present time—the Marine Board of Hobart now consisting of nine Wardens elected by ship-owners, importers and exporters.

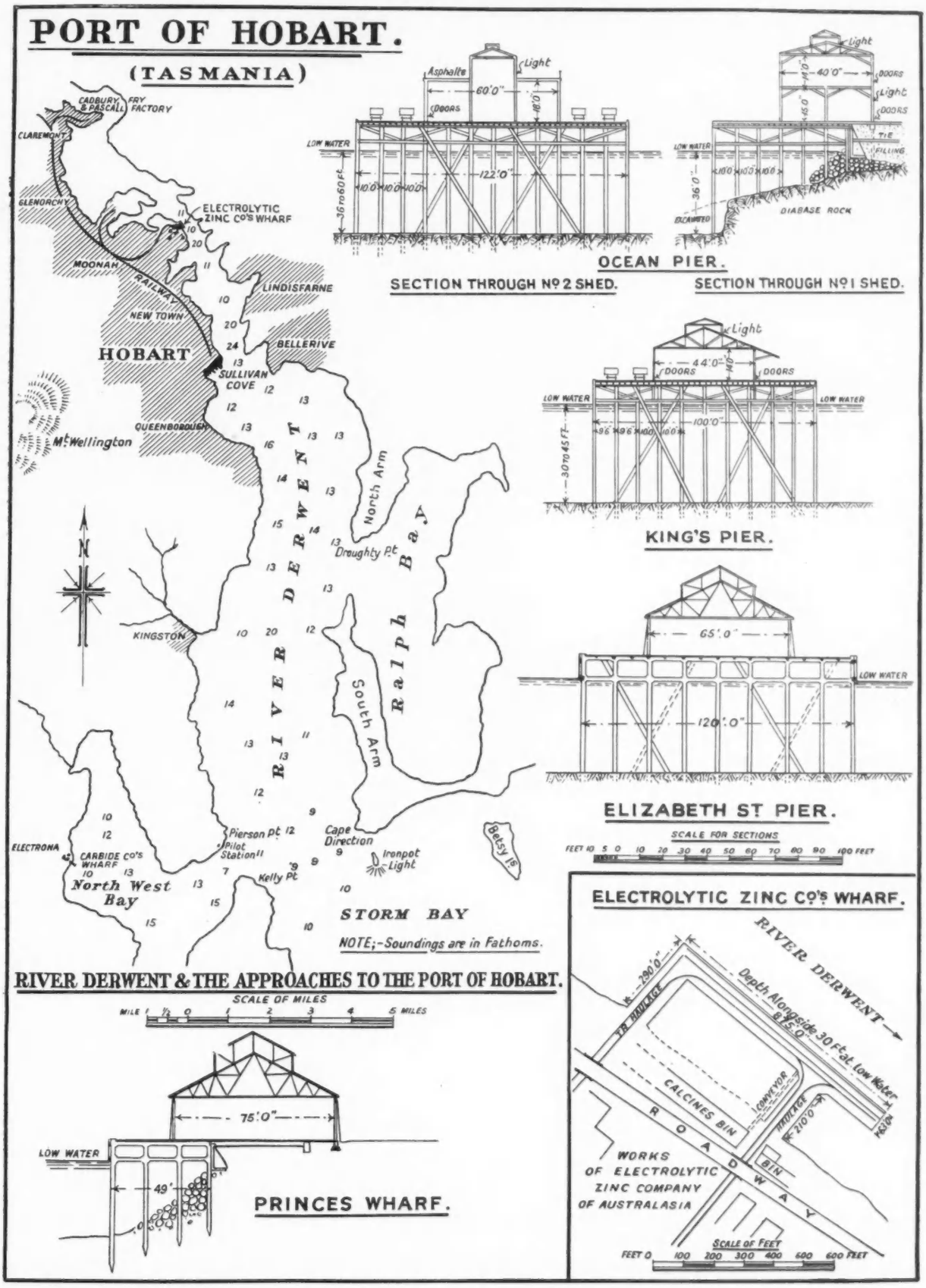
Approaches

There are two approaches from the sea to the River Derwent, on which Hobart with its population of 61,000 stands, namely, through D'Entrecasteaux Channel and through Storm Bay. The latter is generally used both by steamers and sailing vessels, but the Channel approach is also used by large steamers visiting the port. The entrance to the River Derwent from Storm Bay is 2¼ miles wide, with depths of 8 to 10 fathoms, and an average width of about 2½ miles is maintained throughout the distance of 11 miles to Hobart. The soundings in mid-channel increase to 20 fathoms at 5¼ miles above the entrance, thence decreasing to 12 fathoms off the harbour. The River Derwent is free of all dangers, well lighted and easy of navigation, even by strangers to the port, and the harbour itself is well sheltered and perfectly safe in all weathers.

Accommodation

The wharfage accommodation is some 2½ miles in length, and occupies the whole of the foreshore in Sullivan Cove. With the exception of Prince's Wharf and the inner end of Ocean

Port of Hobart, Tasmania—continued



Pier, the accommodation takes the form of piers, and while it is generally recognised that the " Wharf " structure with ample space alongside lends itself admirably to the economical working of cargo, the piers have met requirements so far, although it is now thought, owing to the increased traffic of the port, that they could have been, with advantage, built a good deal wider. The dimensions of the principal berths for oversea vessels are as follows:—

Ocean Pier and Wharf—North side, 650-ft.; South side, 1,142-ft., width 122-ft., depth of water, both sides, from 36-ft. at inner to 60-ft. at outer end.

Prince's Wharf—Length 1,292-ft., depth of water from 30-ft. to 44-ft.

King's Pier—Length 688-ft., width 100-ft., depth of water 34-ft. inner end to 45-ft. outer end.

Queen's Pier—Length 619-ft., width 105-ft., depth of water 32-ft. inner end to 40-ft. outer end.

Elizabeth St. Pier—(All reinforced concrete). Length 500-ft., width 120-ft., depth of water 30-ft. inner end to 52-ft. outer end.

The above depths are at L.W.O.S.T.

Port of Hobart, Tasmania—continued

All the piers and wharves are provided with ample closed-in shed accommodation. A vessel 800-ft. long, with a loaded draught of 36-ft., can be berthed at Ocean Pier with safety without the aid of tugs, and a berth to take a vessel 1,000-ft. long, with a minimum depth of water of 40-ft., could be provided, if needed, in three months. The shed on the pier is 650-ft. long by 61-ft. wide, with a flat roof for the landing of passengers, and in it could be placed 201,600 cases of apples stacked 15 cases high. At the approach to the pier is a two-storey shed, 316-ft. by 40-ft. Some of the piles used in construction were 110-ft. in length, weighing 17 tons, and they were all obtained in the Forests of Southern Tasmania, as well as the 2,000,000-ft. super of sawn hardwood timber required to complete the structures. The whole of the work was carried out by day labour at a cost of £76,620. The Ocean Pier, King's Pier and Elizabeth Street Pier are connected with the State Railway system, and there is a 25-ton steam travelling crane at the inner end of King's Pier.

Harbour Improvements

In 1911, the Board decided upon an extensive scheme of harbour improvements, which included the construction of the Ocean Pier, the diversion of the Hobart Rivulet, and the reclamation of land to the north of the pier. The total area reclaimed to date is about 11 acres, which is all leased to Oil Companies for the storage of petroleum spirit in bulk.

Port Charges

As one might only expect, the Port Authority, with the aid of unparalleled natural advantage which allow of the port being maintained in an efficient manner without the provision of expensive maintenance plant, is able to pass on the benefit to the shopowners in the form of low port charges. It may be claimed fairly that Hobart is by far the cheapest port in the Commonwealth of Australia, as a comparison of charges at other ports with the following will prove.

Pilotage—

Inward—Sailing vessels 6d. per ton net; steamships 4d. per ton net; maximum £15; minimum £4.

Outward—One-half the above rates with a maximum of £5.

No vessel is bound to take a pilot, but the payment of the prescribed fee is compulsory.

Tonnage Rates (Overseas Vessels)—
1¼d. per ton gross; maximum £50.

Port Dues—
Vessels not liable to Tonnage Rates (i.e., not using a wharf under the control of the Marine Board) 1d. per ton gross; maximum £50.

Light Dues at a rate of 6d. per ton are payable to the Commonwealth Government at the first port of call. If the steamer has visited another Commonwealth port before calling at Hobart (as is usually the case) nothing further is collected for a period of three months, which allows a vessel trading to places outside the Commonwealth to visit all the principal ports and leave Australian waters within the period of three months. As an actual example of charges, the R.M.S. "Orcades," 23,455 tons, arrived at Hobart at 9.5 a.m. on the 4th December, 1937, and sailed at 6.5 p.m. on the same day, the Marine Board's account being as under:—

	£	s.	d.
Pilotage In and Out (max.)	20	0	0
Tonnage Rates 1¼d. per ton max. ...	50	0	0
Handling Mooring Lines	1	16	0
Use of Office and Telephone, etc. ...	1	10	6
,, ,, Landing Stages	5	0	0
	£78	6	9

Trade

The trade of the port has shown large expansion within recent years, principally due to the cheap electric power available by the State Hydro-Electric Department for large industrial concerns which have been successfully established on the banks of the Derwent. In 1920, the total tonnage of cargoes passing in and out of the port totalled 335,352; in 1933-34, 624,212 tons, while for the 12 months ended 30th June, 1937, it reached 736,094 tons. And so with the tonnage of vessels the gross tonnage in 1920 being 615,587, in 1933-34—1,665,092, and for the 12 months ended 30th June, 1937—1,849,007.

The principal exports are fresh and canned fruits, metallic zinc, wool, hops, timber, fish, jam, wattle bark, confectionery, etc., and imports—tea, sugar, wheat, tinplates, kerosene, benzine, coal, roofing tiles and iron, and other manufactured goods.

For the 12 months ended 30th June, 1937—2,355,666 bushels of fruit were shipped overseas (nearly all to England), and the total number of bushels exported was 3,327,595 bushels. The export of zinc is now assuming large proportions, the present annual output being about 71,000 tons, and of Cadmium about 250 tons. The works are established on the river front, some three miles above Hobart, and the quality of the commodity is equal to the best the world can manufacture. Super-phosphates are also manufactured at the Zinc Works, for which purpose a plant capable of producing 25,000 tons of high-grade fertiliser annually is in operation.

Still higher up the river, situate on a charming site, is the model confectionery factory controlled by Cadbury-Fry-Pascall, Ltd., and enormous quantities of chocolates and other sweets are now exported to other portions of the Commonwealth.

In addition to jam, canning and biscuit factories, wood-turning works, all situate within a short distance of the city, calcium carbide is produced on a large scale (7,000 tons per annum) at Electrona, situate on the foreshore of North West Bay, D'Entrecasteaux Channel, and timber mills are scattered all over the Channel and Peninsula Districts.

Elizabeth St. Pier

The distances by sea from Hobart to the largest centres of population on the mainland, namely, Sydney and Melbourne, are 628 and 470 miles respectively, and the question may well be asked, why it is that Hobart has been chosen for the establishment of industries the raw material for, and the products of, which have to be transported considerable distances, thus raising the cost of the article as compared with manufacturers whose works are in closer touch with consumers? The answer in most cases is the cheap electric power supplied by the State Government, the equable climate and the magnificent asset the State possesses in the River Derwent.

Port of Rangoon

Excerpts from the Annual Report of the Commissioners for the Year 1937-38

Revenue.—The year's working has resulted in an excess of income over expenditure amounting to Rs. 2,39,557, as against an estimated figure of Rs. 1,59,265. Compared with the previous year, income shows a decrease of Rs. 1,31,406 and expenditure a decrease of Rs. 1,18,465.

The total expenditure during 1937-38 was Rs. 27,10,901.

Traffic.—The total net tonnage of steamers entering the Port was 4,110,471 tons, or 30,119 tons less than in the previous year. Of the 1,543 sea-going vessels that entered, 963 came alongside the Commissioners' wharves and jetties for the purpose of disembarking passengers and discharging cargo, as compared with 921 vessels in 1936-37.

The total sea-borne trade of Rangoon amounted to 5,416,012 tons, representing an increase of 127,879 tons or approximately 2 per cent. over that of the previous year. The figures compare favourably with those of the record year, 1929-30, when the sea-borne trade of the Port amounted to a little over 5.6 million tons. A total of 1,654,059 tons of goods was handled over the Commissioners' premises.

The tonnage of river-borne traffic which passed over the Commissioners' premises amounted to 765,776 tons, showing a decrease of 40,724 tons as compared with the previous year. Rail borne traffic passing over the Commissioners' sidings also showed a small decrease from 780.072 tons in 1936-37 to 753,875 tons this year.

Passenger Traffic.—During the year, 220,230 passengers by sea landed at, and 221,302 embarked from, the Commissioners' wharves and jetties as compared with 227,519 and 208,778, respectively, in the previous year.

The report is signed by Mr. W. D. Beatty, Acting Chairman.

Administration of the Port of Bristol

By R. H. JONES, O.B.E., M.Inst.T., General Manager of the Port of Bristol Authority*

Bristol is a port of great antiquity and has played an important part in the mercantile history of the country. Its ships and seamen have been prominent in matters of discovery, exploration and colonisation, and at the present time Bristol takes a place amongst the large ports in the country.

Its history as a modern port under municipal ownership may be said to have commenced in the middle of the last century, when the City Docks were purchased by the Corporation from the Bristol Dock Company which early in that century had carried out the dockisation of that part of the River Avon which passes through the heart of the city.

Before going into matters of detail relating to Bristol it may be of interest to mention the various forms of administration for docks and harbours in this country and the duties and obligations which rest upon the Authorities administering and controlling them. There are altogether about 330 harbours in Great Britain and their administration may be divided into four categories as follows:—

(a) Local Commissions or Trusts not working for profit, established under statutory authority	110
(b) Municipal Authorities	70
(c) Railway Companies	50
(d) Harbour Companies and individuals	100

The overseas trade of the country is, however, confined to between twenty and thirty of these ports. The other 300 are in the main restricted to coastwise traffic and the fishing industry, but nevertheless they play an important part in the economy of the country as they are used to supply the local population with some of the staple commodities which are imported at the large ports and can be distributed economically by water around the coast.

Many of the large ports engaged in the overseas trade are administered by local Commissions and Trusts, e.g., London, Liverpool, Glasgow, Newcastle, Sunderland, Middlesbrough, Dundee and Aberdeen.

All the railway companies are large owners of docks, of which the principal are at Hull, Southampton and in South Wales. They also own a number of smaller ports used for the Continental and Irish passenger traffic.

Bristol has the distinction of being the only large port in the country which is wholly owned and administered by a Municipality. The Manchester Docks and Ship Canal are owned by the Manchester Ship Canal Company, in which the Manchested Corporation has a large interest and nominates eleven of the twenty-one directors.

Dock and Harbour Authorities are usually established by special Acts of Parliament conferring on them the power to administer and control these Undertakings and to levy charges for the upkeep of the dock or harbour. There are several public Acts relating to the administration of docks and harbours, the principal of which is the Harbours, Docks and Piers Clauses Act, 1847. This Act is usually incorporated in special Acts relating to individual docks and harbours.

Briefly, the duties of these Authorities are to afford safe navigation within the port area, accommodation for vessels and facilities for discharging and loading cargoes, and to make bye-laws for the regulation of vessels and traffic using the port. The Authorities derive their revenue from dues on ships and goods and, in some instances, they undertake labourage services in connection with the handling of goods and the provision of warehouses. The rates at which dues can be levied are limited by statutory maxima, fixed in each case by special Acts. In some cases variation can be authorised by the Minister of Transport. The Authorities are usually allowed to make reasonable charges for labourage and other services and for warehouse rent, and no maxima are laid down.

At some of the larger ports there is a separate Conservancy Authority, distinct from the Dock Authority, of which the Humber, Southampton and Newport are examples. In other cases the Conservancy Authority and the Dock Authority are one body, as at London, Liverpool, Bristol and the Tyne.

A Conservancy Authority is responsible for the safe navigation, lighting and buoying of the approaches to the port, and for the maintenance of navigation channels, whereas the Dock Authority as such is responsible for the control and administration of enclosed docks.

Pilotage Authorities are responsible for the pilotage services and matters incidental thereto, and are often separate bodies from the Dock and Harbour Authorities. At Bristol the Corporation is the Pilotage Authority as well as the Port Authority, but pilotage matters are entrusted to a separate Committee of the Council.

The Port of Bristol comprises the City Docks in the heart of the City about seven miles from the mouth of the Avon, the Avonmouth Docks on the Gloucestershire side of the Avon estuary and the Portishead Dock on the Somersetshire side of the estuary. The following describes briefly these docks, their characteristics and the events which led to acquisition of the original docks by the Corporation.

The City Docks were formed by converting about three miles of tidal river into floating harbour, providing about 83 acres of dock space. These docks remained under the control of the Bristol Dock Company until 1848. A number of reasons led to their acquisition in that year by the Corporation, the principal being that the dues and charges levied by the dock company were regarded as too high, and that the company were not carrying out improvements and providing facilities necessary for the developments taking place in trade.

After the docks passed into the hands of the Corporation many improvements and new works were carried out. Larger locks and extensive new wharves were constructed, railway lines laid to connect a large part of the south side of the docks with the Great Western Railway system, and a large granary erected. The navigation of the River Avon was greatly improved. In 1897 powers were obtained to construct quays and sheds at Canons Marsh on the north side of the docks which was at the same time connected by railways. From time to time other improvements have been made, and the older sheds have been replaced by the modern type of transit shed. A new wharf and transit shed are now under construction.

Vessels up to about 325-ft. in length can navigate the River Avon to the City Docks, but owing to the growth in the size of the ships engaged in overseas trade the City Docks are now used mainly by vessels engaged in the near Continental trade and coastwise services.

In addition to the public quays and wharves there is a number of works, mills, factories and warehouses belonging to private firms and companies abutting the docks, and a very valuable facility of direct water communication is thereby obtained.

The Port Authority owns three large warehouses for the storage of tobacco. Other large warehouses have been provided by private firms. The total warehouse accommodation for tobacco is 230,000 casks.

To meet the need, which had become pressing, for larger and better dock accommodation than could be provided at the City Docks the original Avonmouth Dock was constructed by the Bristol Port and Channel Dock Company and opened for traffic in 1877. The lock is 454-ft. long and 70-ft. wide, and could accommodate the largest vessels then afloat. Another dock company constructed the dock at Portishead which was opened in 1879, the length of the lock being 440-ft. and the width 66-ft. There then began a period of intensive competition between the City Docks, owned by the Corpoartion, and the Avonmouth and Portishead Docks, owned by the two rival dock companies. This competition continued until 1884, when the Avonmouth and Portishead Undertakings were acquired by the Corporation, and since that time all the docks within the port have been administered by the Corporation as a single undertaking.

When the increase in trade and in the size of vessels caused consideration to be given to new dock accommodation a controversy arose over the schemes. One scheme was the dockisation of the River Avon at its mouth and others the construction of a new dock either at Avonmouth or Portishead. In the end, a scheme for a new dock at Avonmouth gained the day, and in 1901 powers were obtained to construct a large dock, with an entrance lock 875-ft. long and 100-ft. wide, adjoining the original dock at Avonmouth. The dock is known as the Royal Edward Dock. The new dock, which was opened in 1908 by H.M. King Edward VII, was designed on the most modern lines to ensure the rapid and efficient handling of all classes of cargo.

Large extensions have since been made. On the western side a new Arm was constructed for vessels engaged in the oil trade. In 1928 another extension, known as the Eastern Arm, was opened by H.R.H. Prince of Wales (later H.M. King Edward VIII), and specially equipped for handling grain and general cargo. A Bill is now before Parliament for power to construct a further extension and the necessary equipment at an estimated cost of over £800,000.

The modern accommodation and facilities provided at Avonmouth for ships and goods have brought a large increase in trade. The overseas trade of the port is now very largely concentrated at Avonmouth Docks, as will be seen from the following table:—

Financial Year	Tonnage of Vessels	Foreign Imports
1910	888,000	523,000
1928	2,222,000	1,521,000
1938	2,864,000	2,508,000

*Paper read at the Summer Conference of the Institute of Public Administration, Bristol, July, 1938, and reproduced by permission of the Institute.

Administration of the Port of Bristol—continued

Of the total tonnage of vessels coming to the port, Avonmouth Docks accommodated 41 per cent. in 1910 and 75 per cent. last year.

All classes of cargo are dealt with at those docks, and much specialised equipment and accommodation have been provided. In addition to the most modern transit sheds and cranes there are floating and shore elevators for discharging grain, silo granaries, warehouses for general goods, cold stores, timber yards and a dry dock 875-ft. long and 100-ft. wide, as well as other numerous mechanical appliances necessary for present-day requirements. All the quays and sheds and warehouses are served by railway lines so that all the goods intended for despatch by railway are loaded into trucks at the docks. The haulage over the dock lines is performed by the Port Authority's own locomotives. There is a railway station at the entrance lock where passengers embark and disembark.

A special feature has been the great development in recent years of the milling industry at the Avonmouth Docks. Large flour mills have been constructed at the quayside, and wheat can be discharged direct from the importing vessels into the mills. Provender mills have also been constructed for the milling and preparation of meals and other feeding-stuffs for live-stock.

Avonmouth is one of the few places where enclosed dock accommodation is provided for vessels bringing petroleum and motor spirit in bulk. The principal oil companies have storage installations at the docks, and about 100 acres of land have been leased for this purpose. The imports are nearly 1,000,000 tons per annum.

The Portishead Dock is particularly laid out to accommodate grain and timber. It is also used extensively for coal, which is brought across the Channel in very large quantities for the Electrical Generating Station situated near the dock. The coal is transferred from the vessels to the station by a conveyor.

At the City Docks the work of discharging and loading vessels is undertaken by the shipping companies or stevedores. At the Granary and Tobacco Warehouses the labour is employed by Port Authority. At the Avonmouth and Portishead Docks the Port Authority undertakes the work of landing and shipping cargo, warehousing as required and all the incidental labourage services. The shipowners usually employ stevedores for the work on board the vessels of discharging and stowing cargo. The tenants having waterside premises also employ their own labour.

I now come to the personnel of the administration and the organisation of the Undertaking. The administration of the Docks Undertaking is vested in the Docks Committee, consisting of eleven members of the City Council, under the title of the " Port of Bristol Authority." The Committee is appointed annually, and at its first meeting the Chairman for the year is elected. The City Council delegates to the Committee the regulation and management of the Docks Undertaking and the exercise of the rights, powers and duties of the Corporation as a Dock, Harbour and Conservancy Authority. The powers so delegated exclude the borrowing of money for capital purposes; this is reserved to the Council.

Although the appointments to the Committee are made annually by the Council at the commencement of each Municipal year, there is in practice a large measure of continuity in service. In the 44 years, 1893 to 1937, there were only four Chairmen, and this continuity, although in a lesser degree, is maintained amongst the members of the Committee. Standing and special Sub-Committees are appointed for matters requiring detailed consideration. The Committee meets once a fortnight, and the Sub-Committees as necessary. The principal Executive Officer is the General Manager with an Assistant General Manager, Chief Engineer and Secretary.

The management and working of the Undertaking are in the hands of the General Manager, who has several departments; the head of each is responsible for the work and duties allocated to it. At the Head Office the General Manager has a clerical staff to deal with the numerous matters of detail incidental to the management of the Undertaking. These include rates and charges for labourage and other services, preparation and examination of statistical returns, matters affecting the development of trade, Parliamentary matters and keeping contact with both old and new customers.

At the City Docks there is a Traffic Manager, who is responsible for the allocation of suitable berths to vessels, the supervision and prompt removal of goods landed on the quays and in sheds. He is also in charge of the granary, cattle lairs and tobacco warehouses. There is also a Dock Master, who is responsible for the locking in and out of vessels and their proper berthing, control and working of swing bridges and, in collaboration with the Traffic Manager, the due observance of bye-laws and regulations by all persons using the docks.

The working of the Avonmouth and Portishead Docks is in the charge of a Docks Superintendent with an Assistant Docks Superintendent. The Avonmouth Docks are by far the most important of the Undertaking, and the Docks Superintendent has a supervisory staff to assist him in carrying out his duties. He is responsible for the general supervision of traffic at the docks, the arrangements for the landing and shipping of cargo, the engagement of the casual labour day by day, the arrangements for the use of cranes, locomotives, grain elevators and other mechanical appliances required, the due execution of orders received from importers for the despatch of their goods and the preparation of accounts for all services performed by his department. He also attends to the requirements of tenants on the Estate as regards the working and movement of their traffic. Under the Docks Superintendent is the Dock Master, who is responsible for the locking in and out of vessels, their berthing in the docks and the observance of bye-laws relating to ships.

The Port Authority maintains a Police Force to carry out the duties of watch and ward on the Dock Estate, which covers about 900 acres. No goods are allowed to leave the docks by road until a pass signed by a duly authorised persons is produced to the Police at the gateways. It is the duty of the Police to examine and verify that the goods in each instance conform with the particulars shown on the pass. Last year 165,000 road vehicles were loaded at the docks. The Police are also engaged on vessels in the petroleum trade whilst in dock, in order to ensure strict compliance with the special bye-laws relating to this traffic.

The Fire Brigade services are provided and maintained by the Watch Committee. The Port Authority makes a contribution towards the cost.

There is a First-Aid Station maintained by the Port Authority at the Avonmouth Docks. An Ambulance service is also available, the cost of which is contributed to by all employers on the docks and the men's Unions.

The Stores Department, which undertakes the purchase and distribution of stores required by the Engineer's and other departments, is stationed at the Avonmouth Docks, and is also under the control of the General Manager.

The Haven Master has his office at Avonmouth, and is in charge of conservancy matters, viz., the lighting, buoying of navigation channels and the River Avon, taking soundings and making surveys. He is also in charge of pilotage matters, for which is is directly responsible to the Pilotage Committee.

The Chief Engineer is responsible for the maintenance of the Undertaking, including repair to dock walls, quays, roads, bridges, fences, ferries, buildings, permanent way, machinery, movable plant, gas, water and electricity mains and scavenging the quays. He is also responsible for the dredging. The Port Authority has a fleet of dredgers, besides auxiliary craft, and the total quantity of spoil dredged during the year is about 3,000,000 tons. The Chief Engineer is also responsible for the preparation of schemes for new works, obtaining new plant and appliances and the layout of sites leased to tenants.

The Secretary is responsible for the collection of dues and other accounts due to the Authority, the accountancy of the Undertaking, the preparation of Agendas and Minutes of the Docks Committee and Sub-Committees, the payment of wages and salaries, the analysis of wages and costing, and the general routine work associated with a Secretarial Department. The Town Clerk acts as Legal Adviser.

The Port Authority has an administrative, technical and clerical staff of 245, and a permanent staff of manual and outdoor workers of nearly 1,000. The Corporation has adopted the superannuation scheme under the 1922 Act, and this applies to all the permanent staff of the Port Authority who occupy designated posts.

Casual labour is employed for the discharge and loading of vessels, and is engaged day by day. The demand for casual workers fluctuates according to the state of trade. There are about 2,600 casual dock labourers registered at the port, and they are employed as required by the Port Authority, shipowners, stevedores and certain of the tenants on the Dock Estate.

There is an Employers' Association representative of the employers of labour at the docks. This Association conducts negotiations with the Unions on questions of wages and conditions of employment. Certain classes of cargo, particularly those in bulk, are worked at piece-work rates of pay, which are fixed locally. Day-work rates are paid on other goods, and are fixed under national agreement, as are also general increases and decreases in wages. Agreements have been negotiated between the local Employers' Association and the men's Unions respecting conditions of employment, the number of men to be employed for particular jobs and kindred matters.

There is also an agreed procedure for settling questions which may arise between workmen and employers, and which might otherwise lead to disputes and, possibly, a stoppage of work. Joint Committees of Employers and Union officials deal with questions of discipline, and any matters which are likely to cause friction. The relationship between the Port Employers and the Unions is on a well-organised basis, and in some respects Bristol is in advance of many other ports.

Administration of the Port of Bristol—continued

Turning to the financial side of the Docks Undertaking, the capital expenditure to date amounts to about £9,300,000. Loans for capital expenditure are raised under statutory powers. Sinking funds operate in respect of borrowed monies. The gross accumulations in these sinking funds now amount to £3,600,000. A large part of these accumulations is used to finance new capital works. The outstanding loans amount to £6,350,000.

The gross revenue last year amounted to £904,000. The principal sources of revenue are dues on vessels and goods, receipts from the handling and warehousing of goods and rents from land and properties. The principal expenditure chargeable to the General Revenue Account is in respect of maintenance of the docks and dredging, the wages and expenses for handling goods, and such expenses as insurances, superannuation contributions, rates and taxes and administrative charges.

The trading surplus last year was £336,000 and the Rate-in-Aid £35,000. After debiting charges in respect of interest and sinking funds and making provision for renewals and contingencies, the balance carried forward was £36,000. It is estimated that the Rate-in-Aid for the present year will be £25,000.

The total charge for interest for the last financial year was £247,070, and included £33,770 for interest on sinking fund monies used to finance new Capital works or applied to the extinction of stock. Sinking funds are provided for the redemption of debt, the period being either prescribed by the special Acts or fixed by the Minister of Transport. The contribution from revenue last year to the sinking fund was £87,571, and represented £11.69 per £1,000 of current debt. In addition, appropriations were made for renewals and contingencies. It is considered that the sinking fund obligations at Bristol are more onerous than those obtaining with other Dock Authorities, and certainly greater in proportion than at London and Liverpool. The reason for the high contribution from revenue at Bristol to the sinking fund is the shorter periods allowed to Local Authorities for the redemption of debt than to other statutory trading bodies. The revenues of the port are sufficient to meet all expenses for the maintenance and working of the docks, the payment of interest on loans and the greater part of the sinking fund contributions. If it were not for the high cost of this last item, for the reason previously stated, a Rate-in-Aid would not be required at the present time.

A statement is appended giving some statistical information with regard to the port and the equipment of the docks.

Port of Bristol

Tonnage of vessels entering the Port. Foreign and Coastwise		3,805,000 tons
Total Imports		4,139,000 ,,
Total Exports		672,000 ,,
Total Imports and Exports		4,811,000
AVONMOUTH DOCKS.		
Length of Quays		14,900 feet
Water Area		84 acres
Transit Sheds	Floor Area	79,000 sq. yards
Granaries	Capacity	62,000 tons
Timber Sheds	Capacity	6,600 stds.
,, Yards	Capacity	8,000 ,,
Cold Stores	Capacity	3,000 tons
Railway Lines		70 miles
Rolling Stock—Locomotives	No.	20
,, ,, —Trucks	No.	820
Cranes	No.	62
Elevators (floating and shore)	No.	11
Grain Barges	No.	14
CITY DOCKS.		
Length of Quays		19,200 feet
Water Area		83 acres
Sheds	Floor Area	49,600 sq. yards
Granary	Capacity	16,000 tons
Tobacco Warehouses	Capacity	38,000 casks
Cranes	No.	46
PORTISHEAD DOCK.		
Length of Quays		3,090 feet
Water Area		21 acres
Granary	Capacity	12,000 tons
Timber Sheds	Capacity	5,000 stds.
Timber Yards	Capacity	8,000 ,,
Cranes	No.	8

DREDGING FLOTILLA.

7 dredgers; 2 steam hoppers; 6 hopper barges

The Institute of Transport

Excerpt from Presidential Address by Mr. GILBERT S. SZLUMPER, C.B.E., delivered 10th October, 1938.

Conveyance by Water

Apart from the pack horse, I suppose it will be conceded that conveyance in ships is the oldest form of transport, and a form in which progress has made rapid strides; sail—except as a hobby—has ceased to be a means of movement on the sea, except for purely local purposes such as fishing, and with it has ceased, incidentally, the form of training that produced rugged, hardy, and resourceful manhood to whom this country's development owes much. But sail has given place to steam or internal combustion-engined ships of immense carrying power and great speed, economic units whose dimensions are limited only by the ports they serve; these vessels now are threatened by the newest form of transport—by the aeroplane—and, like most methods of conveyance, they are having to sacrifice a considerable portion of their paying space to the provision of competitive luxury, this same luxury will doubtless retain many passengers against air competition, but at heavy cost.

The time saving on an Atlantic crossing will doubtless attract many passengers to an air service, but I feel that for some time, at any rate, these passengers will comprise a large number of newcomers, i.e., passengers who would conduct their business by cable or other means if it were not possible to make the round journey between London and New York within a business week.

It is difficult to conceive that an air service will for years to come make serious inroads into the large number of passengers carried by steamship companies on their main routes, and the steamship companies may be relied upon to put up a fairly effective reply to air competition in the form of increased speed of their boats. Owing to the difference in the effective length of life of a vessel and an aeroplane, there may be some time-lag in the delivery of this reply; the aeroplane, with its theoretical life of four years, with probably an actual life of seven years (governed by obsolescence) has a large pull over its more expensive friend the steamboat, which can give 25 years' effective service, from a hull and machinery point of view, and which—during this period—can be kept sufficiently modern in its layout and interior decoration to discount the factor of obsolescence; in other words, there can well be three advances in the design and characteristics of an aeroplane during the life of one ship, so that ships towards the end of their lives will compare badly with the later aeroplanes, but it may still be impossible to justify replacing such ships by newer and speedier ones unless the traffic to be conveyed is of large dimensions; some diversion to air may take place for this reason.

Save for highly perishable or very urgent freight, the cargo situation does not appear to be threatened, but increasing amounts of letter mail go by air, although it is doubtful if the greater portion can be considered urgent—in other words, if the actual cost of conveying it were reflected in the rate charged the probability is that the great bulk would go by sea routes.

In speaking of conveyance by sea, one naturally bears in mind the old controversy of rail v. coastwise shipping, and doubtless when the sea was our only link with the Continent it was necessary to keep afloat a fleet of shallow-draughted small units so that in times of warlike operations they should be ready to carry men, munitions and supplies towards the seat of operations; similarly, it was necessary to keep in efficient condition numerous minor ports from which such ships could sail; but with the mechanisation of the forces and the consequent fewer number of men required to produce the same effect as hitherto, and the probable use of the aeroplane rather than the dismounted soldier, I feel that, from a national point of view, the virtue of the coasting vessel has waned in the same way that hunting is no longer the useful training ground it used to be—which points to a continuance of coastwise shipping only where it is able to exist on a plain economic basis, and this is governed to a considerable extent by the haul on land at each end of the coaster's journey. I see no likelihood of the area of supply at the originating end being enlarged any more than I foresee any extension of the area of delivery or consumption at the termination of the journey; indeed, the only factor which tends to increase is the cost of transferring loads from land to coastwise and vice versa, due to advancing costs of labour operations which are only partially offset by improved mechanical methods of handling.

Canal transit is next in chronological order, and here—apart from speed considerations—the limitation of the size of the carrying unit places a definite barrier to progress, which is also limited by the restricted types of traffic that can afford the length of time a canal journey occupies, compared with other forms of transport. I do not find it possible to foresee any greater use of the canals than now exists, although I often look with envy on the amount of business carried on canals and canalised rivers on the Continent; distances and land levels, however, have made possible a development on parts of the Continent which is not possible in this country.

The Construction of Breakwaters

An Article for Students and Junior Engineers

By STANLEY C. BAILEY, Assoc.M.Inst., C.E., F.G.S.

Fundamental Principles

BREAKWATERS are usually required for one or other of three purposes. One is to form a harbour of refuge for ships in stormy weather, so that they may lie safely at anchor within the area bounded by the breakwater; another is to protect the mouth of a seaport on the side on which the worst storms occur; and the third is to protect river channels at their sea mouths which lead to an inland port.

At the mouths of estuaries and rivers, sand, gravel, and mud banks are formed by the materials carried down by the rivers, and also by the drift of the sea currents and waves along the coasts which carry the materials from one part of the coast to another, and deposit it in the estuaries. These banks block the channels, which must be kept open by constant dredging to enable ships to navigate them safely at high or low water according to the exigencies of the Port. Consequently to avoid the expense of continual dredging, the width of the entrance to the river is reduced by constructing two parallel solid piers from 500 to 1,000-ft. apart into water from 25 to 30-ft. deep at low water; these act as training walls, and the reduction in the width of the entrance produces more rapid currents which scour the shoals between the piers and drive them seawards. The further the piers or breakwaters are carried out into deeper water, the further are the shoals or bars pushed forward and reduced in height.

To carry this process out effectually, it is important that the outer ends of the piers should be in comparatively deep water, but what effect solid piers and breakwaters will have eventually on a harbour entrance is difficult to determine, unless experiments have previously been made with a working model, for the coastal currents in the vicinity are changed in direction as the piers or breakwaters progress seawards, causing new bars to form in unexpected places, the shoals and currents across the entrance making it more difficult for ships to navigate. Occasionally the currents are so strong that vessels are swung round when making the entrance and collide with the pier.

The earliest artificial breakwaters consisted of rubble stone or pierre perdu mounds standing several feet above high water level, and built up by manual labour working from the shore seawards. These gave protection to ships from rough seas, provided the entrance between the breakwaters did not face the direction of the severest storms, but gave little shelter from driving winds, waves, and spray passing over the breakwaters, and because of the small sizes of the stones, these structures became denuded on the sea side, and required constant repairs. The waves not only tore down the outer slopes to flat angles such as slopes of 1 in 5 or 1 in 6, but also pitched the stones into the harbour. In breakwaters of this type it has been found necessary to protect the outer slopes with large stones and concrete blocks weighing from 20 to 30 tons, and to place heavy stone pitching on the slopes, with thick concrete paving over the top, and eventually to erect a mass concrete superstructure on the mound in some instances. In cases of exposed harbours, where there is a comparatively large range of tide, and it is necessary to keep the harbour scoured, two entrances are formed, with a detached mole between them, or a single entrance is left at one end of the mole, and a bridged over gap at the other end. These openings enable the currents to circulate in the harbour and scour the bed. In some cases where small rivers flow into the harbour, the water in them is held up by sluices, which are opened when the tide is low, thus assisting the scouring of the harbour. Double entrances also provide safe alternate entrances for vessels during storms.

Detached moles are constructed by means of hopper barges with hinged bottom doors, so that the rubble can be deposited, but when the mound reaches such a height that the barges can no longer pass over the mound, the stones are handled by cranes mounted on barges, and deposited by tipping buckets or skips with hinged bottoms, the barges lying alongside the breakwater.

Rubble mound breakwaters are the least expensive to construct, but they cost more to maintain than the vertical wall form. Their disadvantages are that they do not give sufficient protection to shipping, which cannot anchor or moor near the breakwater, and it is difficult to construct suitable foundations on the rubble mound for wharves and jetties alongside, unless expensive concrete or masonry walls are built. The entrances between the moles or breakwaters must also be wider than need be, because of the flat slopes of the mound, unless they are finished as in some cases with mass concrete or blockwork heads, or caissons filled with concrete.

When the rubble stonework is deposited on a thick bed of mud or quicksand at the botttom of the sea, the weight of the breakwater causes considerable settlement of the central portion which may be so much as 10 or 20-ft. This produces upheavals of mud and sand, in wave-like mounds on each side of the breakwater and so diminishes the water depth in the harbour. The settlement may continue for years involving continual maintenance and dredging of the harbour.

For the maintenance of the breakwater a permanent railway track is retained along the crest.

Breakwaters of this type are also constructed by means of a timber piled staging built from the shore on the line of the work slightly above the level of the breakwater top, carrying a railway, so that trains of tipping trucks can be run down direct from the quarry, or an overhead cable way transporter may be used for depositing the rubble.

In some cases, the mounds are begun by depositing dredgings of sand, gravel, and stones along the line of the breakwater to form a bearting, on which stones weighing about $\frac{1}{2}$ ton or 8 cub. ft. are deposited, and over these, stones weighing 1 to 2 tons or 16 to 32 cub. ft., with large stones or concrete blocks of 10, 20 and 30 tons on the sea side slopes laid pell-mell or in no regular order; in fact the more irregular they are arranged, the better they break up the waves. In cases where there are considerable depths of mud, and to avoid undue settlement of the breakwater, it is advisable to dredge a trench on the line of the breakwater, and fill it up with dredgings of sand, gravel, and stones.

The outer ends of the breakwaters or moles are provided with lighthouses and beacons well above high water level, constructed either of steel framing or concrete. The former offers the least resistance to the waves. On the shore two prominent landmarks or beacons with lights, one at some distance behind the other, are set up, in alignment with the centre of the harbour entrance, to act as a guide for shipping entering the Port. The slopes of the rubble mounds may be so steep as 1 to 1 on the harbour side, but on the sea side they should not be steeper than 3 to 1 above high water, and 5 to 1 from high water to 12 or 15-ft. below low water level; below this they may be 2 to 1 and $1\frac{1}{2}$ to 1 to the sea bed. The width at the top of rubble mound breakwaters varies from about 20 to 50-ft., and the height above high water spring tides from 9 to 15-ft., but the higher they are built, so much the better, as breakwaters that are not carried up well above the highest spring tides simply acting as groynes, the seas carrying sand and shingle over the top, and depositing it in the harbour where it blocks the channels.

If berms or flat ledges are made in rubble mounds to break the long slopes, they should always be placed at a level of from 12 to 15-ft. below low water level.

Typical Examples

The diagrams in Figs. No. 1 to 10 illustrate various types of breakwaters that have been constructed, and are self explanatory.

Some of the older types of breakwaters consisted of a rubble stone mound brought up to low water level and surmounted with a vertical masonry superstructure. This involves tidal work, and is a slow method of construction. Examples of this type are the breakwaters at Holyhead, Kingstown, Boulogne-Sur-Mer, Cherbourg, Oran and Algiers.

After the founding of the masonry superstructure slightly above low water level, the rubble mound was carried up on each side above high water, and the outside was covered with blocks of large stones laid pell-mell, sometimes the blocks were made of masonry with either cement or Blue Lias lime, and weighed from 28 to 30 tons each. Masonry blocks are not satisfactory, as they are easily broken by heavy seas.

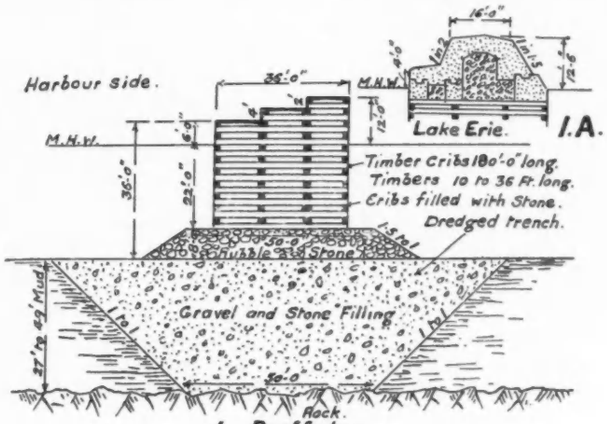
Breakwaters constructed of timber cribwork filled with stones and then sunk on the line of the breakwater are not uncommon in the United States of America, and in Canada.

At Buffalo South Harbour on Lake Erie (Fig. 1), the breakwater is of this type of construction and was completed in October, 1900, but in the following November, a heavy gale with a wind velocity of 80 miles per hour, completely destroyed and broke up the 6 inches thick decking, and the upper portion of the structure, which had to be reconstructed with concrete

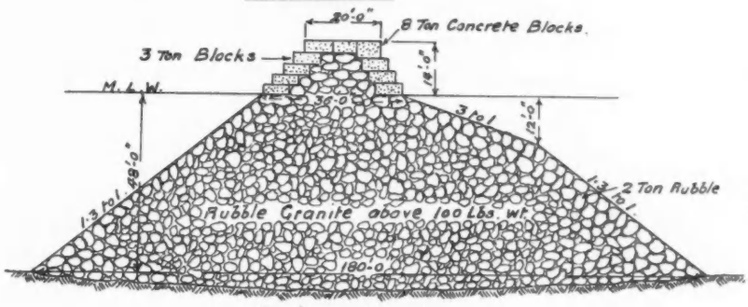
The Construction of Breakwaters—continued

blocks and mass concrete with rubble stone filling inside as shown in Fig. 1a. The waves and spray that broke over the work were estimated to be from 75-ft. to 125-ft. high.*

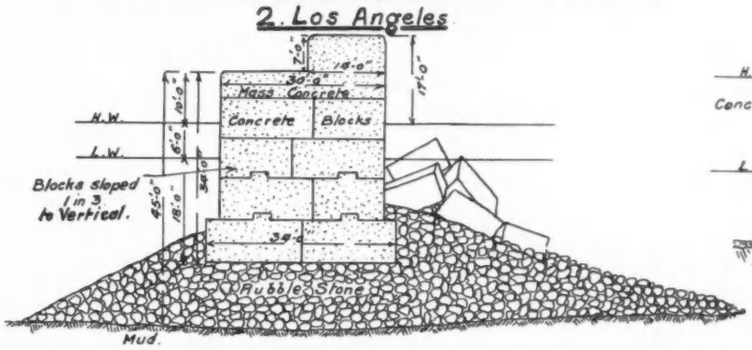
The breakwaters at Bizerta and Algoma consist of reinforced concrete caissons floated out and sunk in sitû by filling them with rubble stone. At Algoma the caissons are 24-ft. long,



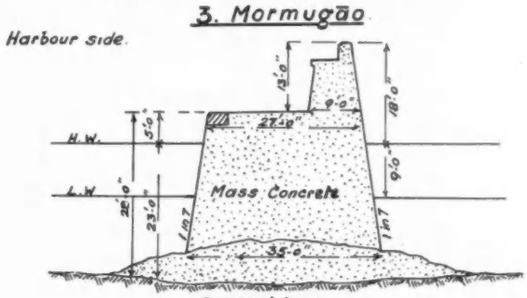
1. Buffalo.



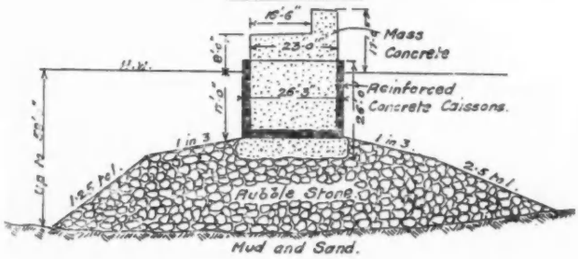
2. Los Angeles



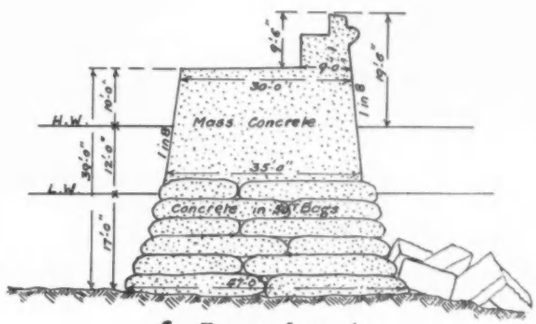
3. Mormugão



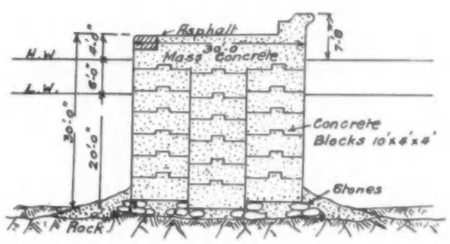
4. Wicklow.



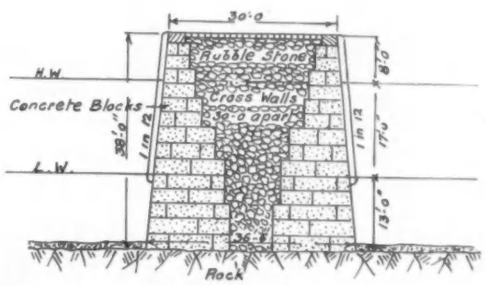
5. Bizerta.



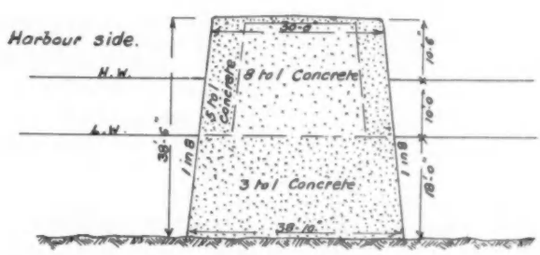
6. Fraserburgh.



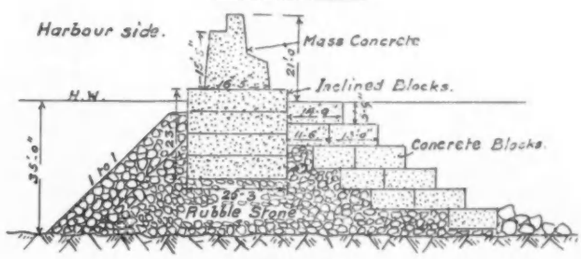
7. Kalk Bay.



8. Braye.



9. Buckie.



10. Constanzia.

The breakwater at Toronto is also constructed of timber crib-work filled with rubble stone, and surmounted by mass concrete, and as these breakwaters are in practically fresh water, the timber is not attacked by mollusca or crustaceans.

and 12-ft. 4-in. deep and rest on piles, the rubble mound having slopes of 1 to 1 on each side.

The caissons are partly filled with rubble stone, and the upper portion with mass concrete.

This is a convenient method of construction provided the caissons are entirely filled with concrete, as weight is important

* "Engineering News," New York, 27th May, 1902.

The Construction of Breakwaters—continued

in such works, because of the buoyancy of the water, and the walls of the caissons are too thin, without a backing of concrete to withstand heavy wave pressures.

The old piers at the mouth of the river Tyne, also at Dover, Ramsgate, and Braye harbours, consist of masonry walls founded on the rock bed. Breakwaters consisting of mass concrete deposited inside timber shuttering and resting direct on the rock bed have been constructed in several places. The concrete is lowered in buckets or skips having hinged bottom doors, by a crane mounted on a barge or lighter, or is passed into a rectangular metal tube or tremie reaching from the bottom to the surface, with a hopper at the upper end, and is trimmed and levelled by divers. It is advisable to use a quick setting cement for this purpose.

The outside of the top of the parapet wall of breakwaters is sometimes finished with a bull nosed corbel which is effective in throwing the spray from ordinary breaking waves back over the sea, but in heavy gales there is little advantage gained by this projection.

Mass concrete breakwaters founded direct on rock are the most stable, as they are not waterborne, while mass concrete and blockwork breakwaters founded on rubble mounds are the least stable.

Concrete in Bags

A number of breakwaters that have been founded direct on rock have been constructed of jute or canvas bags filled with concrete. This has been done to avoid the use of shuttering, and to ensure that a better quality concrete forms the base, than can be obtained by depositing the concrete direct into the water without any protection, as this is liable to become light and porous due to the cement being washed out.

Experiments have been made on sand and gravel deposited on the sea bed, into which long vertical iron tubes have been driven, and neat quick setting cement grout forced down the tubes by compressed air, but these did not prove satisfactory, as the consolidation of the mass became patchy, the hardening taking place chiefly in the vicinity of the tubes.

The canvas for the bags used weighs from 20 to 22 ozs. per sq. yard, and a double thickness is given to the bottom and sides of the bags, while jute for bags weighs 24 ozs. per sq. yard.

In some cases the bags are large, and equal in length to the full width of the breakwater; when small, they are filled with concrete, sewn up, and lowered by a crane mounted on a pontoon, being set in position by divers, but when large, say 30 to 50-ft. or more long, the canvas or jute is placed as a lining in an open-top box, about 6-ft. wide and 4-ft. high, into which the concrete is poured direct from a machine mixer; and when full the upper canvas flaps are sewn together, and the box, which has a hinged bottom, is lifted by a crane mounted on a pontoon and lowered into the sea over the site indicated by a diver. When near the bottom the hinged doors are opened, and the bag falls out.

In some cases the bags are filled with concrete and deposited by a hopper barge with hinged bottom doors. Bags of concrete may weigh from 40 to 100 tons, and the concrete is usually in the proportions of 1 to 3, or 1 to 4.

The bags flatten considerably when laid, and there are usually interstices between consecutive bags, but these can be filled with concrete deposited by skips, or by using small bags.

It has been found that small bags filled with dry concrete and deposited in the sea, will set as hard as wet concrete, but large bags of dry concrete set on their surface for a certain depth, and the hearting remains unset.

Concrete Blockwork

Concrete blocks for the construction of breakwaters of the vertical type, and to act as wave breakers, usually weigh from 30 to 50 tons or more, and are made in the proportions of 1 cement, 2 sand, and 4 of gravel or broken stone up to 2 inch size. They are constructed in timber moulds in a blockyard adjoining the site of the breakwater and are left from 6 weeks to 2 months to harden before being lifted and stacked, usually two tiers high, until required for the work.

The blocks are usually about 12-ft. by 6-ft. by 6-ft., and it is advisable to have as few different sizes as possible.

The blockyard is laid out between the rails from 50 to 65-ft. gauge of a travelling " Goliath " crane, or between the trestles carrying a travelling gantry crane. A central set of rails carry a travelling machine mixer for making the concrete. The cement and aggregate are carried on the platform of the mixer, while the water required is tapped at intervals from a pipe laid on the ground. The concrete is deposited direct into the moulds on each side by tipping up the mixer.

The blocks when set are lifted by the "Goliath" crane on to special railway trucks for conveyance to the "Titan" cantilever crane travelling on the breakwater, which is built up the full height from the shore seawards.

For lifting purposes, the blocks have either grooves on each side, and underneath, near each end, so that slings can be placed round them, or else two Lewis bolt holes are made in the top for the same purpose, and Lewis bars with connecting links, resembling a parallel ruler are inserted in the holes, and are attached to the slings of a cross beam hung from the sheaves of the crane; or they may be lifted by cross pivoted claws or lazy longs, engaging with notches in the sides of the blocks, or by means of hammer headed bolts passing through holes in the blocks. "Goliath" cranes have usually a lifting capacity of from 40 to 60 tons. "Titan" cantilever cranes for depositing the blocks in the sea are generally of the revolving type mounted on a turntable, but in some cases they have only a certain sector of action, depending upon the width of the breakwater. The length of the outer arm in the largest cranes from the centre of the turntable varies from 110 to 150-ft., and that of the inner arm from 50 to 75-ft., while the total weight of the crane may be so much as 400 tons, and the lifting capacity 50 tons at 100-ft. radius, or 100 tons at 50-ft. These cranes are usually retained as part of the permanent plant for future repair to the breakwater after its completion.

Occasionally very large concrete blocks are required weighing from 200 to 350 tons or more, these are usually constructed on a slipway and are slid into the sea. Slings are placed round the block, and two barges or lighters are brought over the site of the block at low tide, one on each side, the slings are made fast to the barges, and as the tide rises the block is lifted, and is then conveyed to the site of the breakwater and released. In some cases a single lighter is used, with special lifting gear passing through watertight sleeves in the bottom of the lighter.

Several breakwaters have failed because the blocks have not been properly keyed and bonded together, there being a vertical through joint down the centre of the structures, with the result that the breakwaters have split into two sections longitudinally.

Most modern breakwaters are now constructed with concrete blocks inclined to the vertical at angles of 15 to 20 degrees, this is done to provide for settlement in the rubble mound, as this may continue for years after the completion of the breakwater. If the settlement is uneven, the blocks slide down, and leave cavities between the top blocks and the mass concrete covering about 6-ft. thick, these cavities can be filled with concrete through large holes drilled in the mass concrete covering.

Blocks should always when possible break joint with one another, and dowels or joggles should be inserted between the blocks, consisting of 1 to 3, or 1 to 4 cement concrete in bags about 1-ft. in diam. or square, and 2 to 3-ft. long, let into grooves in the blocks.

As regards the reduction of the effects of high waves, or range action producing ground swells in the harbour during storms; should the entrance be between piers with a head wind blowing direct into the harbour, there will be little reduction unless the space between the piers widens further in, and to reduce the range effect, pockets or bays should be formed on each side of the shore ends of the piers to act as wave traps, the increased area given will thus reduce the height of the waves, and the ground swell in the harbour.

Harbour Entrances

The widths in feet of the entrances between breakwaters and piers at various Ports are as follows, viz:—Sunderland 700, Dover 650 and 740, Gibraltar 600 and 650, Whitby 170, Tynemouth 1180, Table Bay 250, Port Natal 600, East London 400, Durban 600, Madras 550, Dunkirk 400, Calais 400, Havre 350, Algiers 500, Bilbao 650, Marseilles 820, Tampico 970, Fiume 600, and Adour 550.

To reduce the strength of the currents flowing out of the harbour, which in some harbours amounts to from 2.5 to 3.5 knots, when the tide is falling, or vice versa, the width of the entrance must depend upon the depth of water, and the maximum range of the tide, bearing in mind that the water will heap up more in narrow entrances than in wide ones, that wide entrances are safer for ships to enter during storms, and that the maximum velocity of the water occurs at half tide.

Wave Action

For the open sea the waves are oscillatory and may reach heights of from 30 to 40-ft. during heavy gales, but near the coast waves of translation seldom exceed 12 to 15-ft., although waves from 20 to 30-ft. high, with periods of 8 to 10 seconds between each wave have been measured at the outer ends of breakwaters during cyclones.

The solid water passing over a breakwater may reach 30-ft. in height above the mean sea level, and the spray up to 100 and 125-ft. The waves of translation near the shores are due to the friction of the ground.

Thomas Stevenson measured with a dynamometer the pressures of waves exterted against breakwaters on the Atlantic

The Construction of Breakwaters—continued

and North Sea coasts of Scotland, and found the maximum to range between 1½ and 3½ tons per sq. ft., and Professor Jorge Lira of the University of Chili, has estimated that waves may produce pressures of from 4 to 4.82 tons per sq. ft. during heavy gales ("Le Genie Civil," vol. 90, 1927), while Professor Luiggi estimates the maximum pressure of 20 to 25-ft. waves at sea level to amount to 2.79 tons sq. ft.

It is probable that these pressures are only quite local, and do not occur over the whole exposed area of the breakwater, in the same way as the maximum pressures exerted by wind against structures are confined to small areas, otherwise few vertical wall breakwaters would stand such heavy pressures, as in most of them the base width is less than the height, but is is advisable that the width of the base should not be less than the total height of the exposed vertical wall. The following formula for the pressure exerted by horizontally moving water against a vertical wall is based on the velocity of wind, where

Two conditions have been calculated for, viz: the weight of the breakwater including top water pressure, opposed to lateral water pressure, and (2) the weight of the breakwater alone against lateral water pressure.

The water pressure is taken at 1.6 tons sq. ft. at the base, due to the 55-ft. head of water caused by the rise of the waves as they strike the wall.

The total weight of the blockwork allowing for the waterborne portion is 78.9 tons per lin. ft. and including 15 tons of top water it is 93.9 tons. The mean wave pressure on the outside amounts to 1.35 tons per sq. ft. x 55-ft. = 74.25 tons per lin. ft., while the water pressure on the inside up to H.W.S.T. level is 18.5 tons per lin. ft.

The water moments will be as follows for the whole wall, viz.:—

M. of wave pressure = 74.25 x 26.5-ft. = 1967.62-ft. tons.
M. of H.W. on inside = 18.5 x 12-ft. = −222.00.

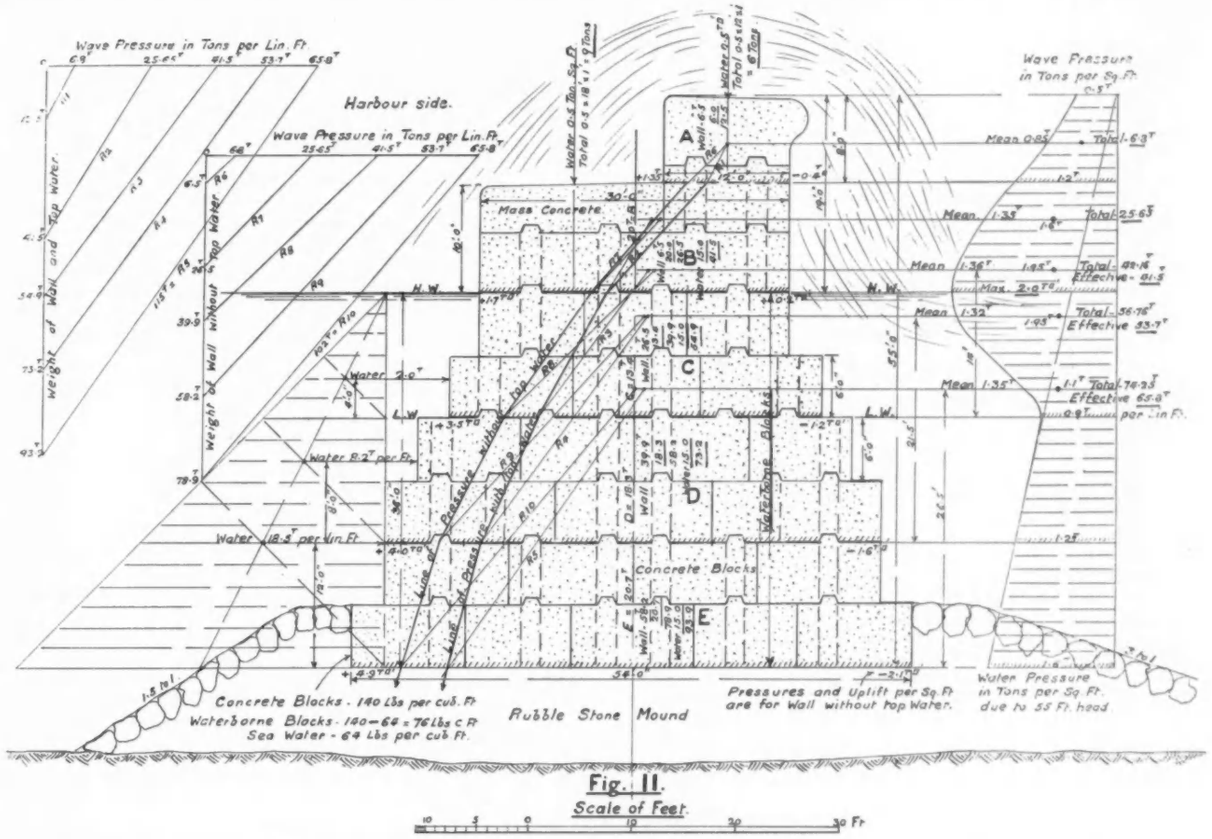

Wave Pressure in Tons per Lin. Ft.
Harbour side.
Weight of Wall and Top Water
Weight of Wall without Top Water
Mass Concrete
H.W.
L.W.
Water 2·0ᵀ
Water 8·2ᵀ per Ft.
Water 18·5ᵀ per Lin. Ft.
Concrete Blocks
Line of Pressure with Top Water
Line of Pressure without Top Water
Wave Pressure in Tons per Sq. Ft.
Mean 0·8ᵀ Total 1·6ᵀ
Mean 1·35ᵀ Total 25·6ᵀ
Mean 1·36ᵀ 1·95ᵀ Total 49·16ᵀ Effective 41·5
Max. 2·0ᵀ
Mean 1·32ᵀ 1·95ᵀ Total 56·16ᵀ Effective 53·7ᵀ
Mean 1·35ᵀ 1·1ᵀ Total 74·35ᵀ Effective 65·8ᵀ per Lin. Ft.
0·9ᵀ
Water Pressure in Tons per Sq. Ft. due to 55 Ft. head
Concrete Blocks - 140 Lbs per cub. Ft.
Waterborne Blocks - 140 − 64 = 76 Lbs c. Ft.
Sea Water - 64 Lbs per cub. Ft.
Rubble Stone Mound
Pressures and Uplift per Sq. Ft. are for Wall without top Water.
Scale of Feet.

Fig. 11.

the pressure in lbs. per sq. ft., $P = 0.00322V^2$, when V is the velocity in miles per hour, or $P = 0.00149V^2$, when V = feet per second. The Sp. Gr. of air = 0.001293 = 0.08072 lbs. per cub. ft., and that of sea water = 1.027 = 64 lbs. per cub. ft., this is a proportion of 1 to 795.

Therefore the pressure of moving sea water in lbs. per sq. ft. = $P = (0.00149 \times 795)\ V^2$ or $P = 1.184\ V^2$, where V = ft. per sec. A pressure of 3 tons per sq. ft. = 6720 lbs. would be equivalent to a velocity of $V = \sqrt{\frac{P}{1.184}} = \sqrt{\frac{6720}{1.184}} = 75.33$ ft. per sec. or 49.4 miles per hour, but waves striking a breakwater are in the nature of hammer blows, and water falling from a height will have a pressure head in feet $= H = \frac{V^2}{2g} = \frac{V^2}{2 \times 32.2}$ and a velocity in vacuo $= V = \sqrt{H \times 2.g}$ where V = feet per second.

The diagram, Fig. 11, shows the calculations for the cross section of a typical blockwork breakwater that would be required to safely withstand a uniform wave pressure at high tide level of 2 tons per sq. ft.

It is 46-ft. high and 54-ft. wide at the base, and stands 10-ft. above H.W. on the harbour side and 19-ft. on the sea side, being founded on a rubble stone mound in 44-ft. of water at H.W.S.T.

The weight of the concrete has been taken at 140 lbs. per cu. ft. (16 cu. ft. per ton) and that of the waterborne portion below H.W. at 140-64 = 76 lbs. per cu. ft.

Waves breaking over the structure are estimated to give a pressure of 0.5 ton per sq. ft., which is equivalent to a column of water 17-ft. 6-in. high, or to that of aerated spray about 50-ft. high, although the momentum of falling water will exceed this pressure.

A difference of 1745.62 ft. tons in favour of the water pressure.

The height of the mean centre of pressure will be—

$\frac{1967.62 + 222}{74.25 + 18.5} = 22.52$ ft. and $\frac{1745.62}{22.52} = 77.5$ tons effective pressure from waves or $\frac{1745.62}{26.5} = 65.8$ tons effective pressure at 26.5 ft.

It is immaterial which figures are taken, as the resultants will fall through the same point, so the latter method has been adopted for the calculation of each section of the wall.

The overturning moments for the worst condition, that is without top water pressure will be:—

M. of breakwater = 78.9 x 27-ft. = 2130.3 ft. tons.
M. of wave pressure = 65.8 x 26.5-ft. = 1743.7-ft. tons, giving a factor of safety of 1.22, against overturning, and the line of pressure falls 5-ft. inside the inner toe, with a pressure of 4.9 tons per sq. ft. and an uplift of—2.1 tons per sq. ft. at the outer toe, this will be sufficient to cause the outer joints of the blockwork to open, and produce a breathing effect on the breakwater, which invariably takes place during heavy gales.

The impact of waves on blockwork breakwaters also compresses the air in the back joints and when the waves recede, the imprisoned air expands, and under considerable pressure forces out the blocks on the face to the extent of several feet in some cases, when the blocks are not well keyed or dowelled together. Suction also plays an important part in the destruction of breakwaters, as it does in the denudation of beaches.

When concrete superstructures are constructed on rubble stone mounds, the tops of the mounds should be kept at least 15-ft. below low water level, so that the stones may be less

The Construction of Breakwaters—continued

disturbed by wave action or the ground swell, which in heavy gales seldom extends to more than 25 to 30-ft. below the water level.

Waves are most dangerous at the beginning of the ebb after high water, when the tide runs out against the seas, and causes the waves to mount higher.

Wave breakers formed of concrete blocks laid pell mell have interstices between them amounting to from 20 to 33 per cent., and are reduced in weight by their buoyancy, their actual weight in sea water being about 0.542 of their weight in air, thus a 30-ton block will only weigh 16.26 tons in the water, and is liable to be displaced by heavy seas if near the water level, while rough granite blocks weigh 0.623 of their actual weight when immersed.

Deterioration of Structures in Sea Water

The issue of the Department of Scientific and Industrial Research of the seventeenth (interim) Report of the Committee of the Institution of Civil Engineers on the Deterioration of Structures in Sea Water* is a matter of special interest and importance to all who have to deal with the maintenance and upkeep of works in a marine environment. Within its 30 odd pages, the booklet contains much detailed information which cannot very effectively be summarised in a brief review, and all that is possible is to select some of the more prominent points for notice.

Timber

The results, in regard to timber, are not always consistent and uniform. In certain cases there is a diversity of evidence which calls for a close examination of the local conditions. Thus timber posts from Singapore, impregnated with creosote with the addition of D.M. (chlorodihydrophenarsazine) in various proportions, which had been sent home for examination during the year, showed wide differences in impregnation, as a result of which no conclusion could be drawn as to the effectiveness of the D.M. addition. In places where the impregnated skin had been attacked by Limnoria, Teredo had gained access to the middle of the posts. Posts returned from Auckland (N.Z.), probably by reason of lighter attack, were in remarkably good condition, several being intact. Treatment with D.M. and Carbazole in small concentrations would appear to be quite ineffective and, indeed, seemed to invite Teredo attack. A post treated with creosote, plus 0.1 per cent. of D.M., at Wellington, was very severely attacked by Teredo and Limnoria, while a second post, treated with creosote, plus 0.03 per cent. of D.M., was in good condition externally, only a few Teredo holes being noticed. No conclusions could be drawn therefrom, except that the preservative value of the treatment was evidenced, even in the former case, by the relative resistances of the skin and the interior. The number of specimens left extant after 12 years' exposure indicates the value of creosote, either alone, or as the vehicle for a poison. Thus any additional protection, which such a poison might confer, escapes detection, and, as in many previous experiments with creosote, it has not been possible to assess the value of the added poison.

Naphthalene is another substance which has been experimented with as a preservative. Specimens returned from Mauritius, after six years' exposure, showed severe attack by Limnoria. Specimens treated with creosote only, and with creosote, followed by a bath in naphthalene, appeared to be less completely destroyed than those treated with a mixture of creosote and naphthalene, or with naphthalene, plus D.M. Blocks from Takoradi, Gold Coast, after six years' exposure, indicated that creosote, plus 3 per cent. of D.M., gives better protection than creosote alone. However, impregnation was poor in one case, and the result is indefinite. It would appear that while creosote alone affords little protection from Limnoria, the addition of D.M. has a deterrent influence.

The effect of incising the timber has been investigated. Both incised and unincised specimens at Colombo were attacked by Limnoria and Teredo, about one-half the number of one set remaining sound, and the second set left almost intact. The result of incision is greatly to increase the absorption of the creosote, the averages being for the first set: unincised, 2.7 lbs. per cu. ft., incised 6.3 per cu. ft. for the second set unincised, 7.5 lbs. per cu. ft. incised, 17.4 lbs. per cu ft. Thus, while it is apparent that protection increases with the amount of creosote absorbed, it has not been possible to draw definite conclusions regarding the value of incision. Although there is no doubt that it does confer additional protection, there are indications that, if the creosote could be evenly absorbed, without the use of incisions, it would be more effective. And it may be added, though the report is silent on the point, that there would be less risk of weakening the timber.

Other tests with Pintsch gas tar as a protective medium showed that it afforded considerable protection, but that it was unquestionably inferior to creosote.

It is of interest to note that there was complete immunity from attack in untreated turpentine during 12 years' exposure at Wellington. Untreated pynkado also remained quite sound after 12 years' exposure at Auckland. Greenheart is stated to be still in good condition in that locality after 20 years, though there are several Teredo holes in the untreated wood and a few in that painted with crude creosote. At Leith, the timber is practically immune after 13½ years' exposure.

Iron and Steel

The corrosion of iron and steel has been examined in specimens exposed at Auckland, Colombo, Halifax and Plymouth. The results are varied, but they indicate the superiority of chromium steel and 36 per cent. nickel steel over unalloyed metal.

Sir Robert Hadfield has investigated a claim made by Shun-Ichi Satoh, a Japanese contributor to the Journal of the Institute of Physical and Chemical Research, that nitrided austenitic manganese steel exhibited the highest potential in sea-water and never became rusty. Sir Robert's experiments failed to confirm the assertion.

Reinforced Concrete

As regards reinforced concrete, all the results tend to endorse the conclusion previously arrived at that the failure of reinforced concrete piles is directly related to corrosion of the steel reinforcement, and therefore to the probable access of sea-water.

The main report is supplemented by five subsidiary reports, respectively by Prof. George Barker giving a Summary of Work on the Protection of Timber; by Dr. Newton Friend on Losses in Weight and Pitting in the Iron and Steel Specimens; by Dr. R. E. Stradling on the Deterioration of Reinforced Concrete Test Pieces in Sea Water; by Sir Robert Hadfield on Experiments on Nitrided Austenitic Manganese Steel, and by Dr. Carl Benedicks with a Summary of Conclusions on the 5-Year Tests of the Iron and Steel Specimens.

The collection and analysis of experimental results as to the effect of a marine environment on structural materials is necessarily a slow process, and an appreciable length of time must elapse before the area of investigation and the number of specimens treated will admit of the drawing of definite conclusions, but every addition to the knowledge of the subject is a step forward in the elimination of a serious menace to the permanency of port works.

* H.M. Stationery Office. Price 9d. net.

New York Harbour Entrance Channel

The Annual Reports for 1937 of the Chief of Engineers, U.S. Army Corps, recently issued from the U.S. Government Office, Washington, describe a number of improvements which have been effected in various navigable waters in New York Harbour, chiefly the principal channels and anchorages in the Lower and Upper Bays, including the Ambrose, Main Ship, Bayside and Gedney Channels, together with others of lesser importance.

Dealing with the main entrance channels as being of most interest from an international navigation point of view, it is to be gathered from the Reports that the project in hand is the provision in the Ambrose Channel of a depth of 45-ft. of water with a width of 2,000-ft., for a length of about 7½ miles from the sea to deep water in the Lower Bay; in the Anchorage Channel, which is an extension of the Ambrose Channel, the same width and depth in the Upper Bay, opposite the anchorage grounds, for a length of about five miles; in the Bayside-Gedney Channel, a depth of 35-ft. with a width of 800-ft., for a length of about 6¼ miles from the sea to Raritan Bay; and in the Main Ship Channel, a depth of 30-ft. with a width of 1,000-ft., for a length of about 4¼ miles from Raritan Bay to deep water in the Lower Bay. These depths refer to mean low water. The mean tidal range is 4.7-ft., with irregular fluctuations, due to wind and barometric pressure, from 4-ft below mean low water up to 4-ft. above mean high water.

At the conclusion of the 1937 fiscal year, it is stated that the existing project was about 56 per cent. completed. Main Ship-Bayside-Gedney Channel was completed in 1891. Ambrose Channel was completed to a depth of 40-ft. in 1914. Anchorage Channel was re-located to the eastward and completed to a depth of 40-ft. in 1932.

The controlling mean low-water depths of the main channels are as follows: Ambrose Channel, 45-ft. for a width varying from 500 to 2,000-ft. (August-September, 1936); Main Ship Channel. 30-ft., 450 to 1,000-ft. wide (September-October, 1936); Bayside-Gedney Channel, 30-ft., 500 to 800-ft. wide (September-October, 1936); Anchorage Channel, 45-ft., 800 to 2,000-ft. wide (September, 1931, February-July, 1936). The work remaining to be done consists in dredging Bayside-Gedney Channel, 800-ft. wide, 35-ft. deep, and the deepening of Ambrose and Anchorage Channel to 45-ft. for a width of 2,000-ft., as authorised in 1937.

Southampton Docks Extension

Discussion on Paper by Mr. M. G. M. McHAFFIE, M.Inst.C.E.*

(Concluded from page 364)

Mr. N. G. Gedye remarked that on several occasions during the construction of the works described he had had the pleasure of examining them in some detail, under the guidance of Mr. Wentworth-Sheilds, the Author, and others, and he had been particularly struck by the efficient working of the two appliances employed for excavating the wells of the monoliths; they seemed to be extraordinarily effective, and to have overcome the very serious difficulties which had been met with in sinking through the harder beds. Could the Author give some indication of the volume of water discharged into the dock through the permanent relief-pipes referred to on p. 292?

The difficulties that were encountered in carrying out one of the subsidiary works which had not been mentioned in the course of the discussion (namely, the culverts and intake pipes which were laid across the reclaimed foreshore) were considerable. He had several times examined those deep trench excavations, and he had given some advice in connection therewith to the contractors who were carrying out the works. The pressure exerted by the semi-fluid material of the foreshore was great, and the whole trench, as the Author recorded, moved in places towards the channel. That was one of the minor but important difficulties overcome by the engineers and the contractors in the course of carrying out the works.

He would also like to mention the very successful application of tube-well dewatering on the site of the graving dock. The German system had been applied, and it seemed to have been extraordinarily effective. About the same time that that work was being done, he had had occasion to see a series of pumped wells employed in dealing with artesian water under somewhat similar conditions in the construction of the new Albert Canal which was being built in Belgium between Antwerp and Liège. There the cutting was carried through high land, consisting of soil of a very treacherous nature, which lay above a subsoil near the bottom of the cutting which was under an artesian pressure approximately equal to the pressure at Southampton. The contractors in Belgium had been able, by means of those artesian wells, to keep the whole of the cutting dry during the construction, and to lay a permanent system of drainage-pipes throughout the cutting beneath the canal bottom in order to discharge the water into the lower reach at the end of the cutting. Without having recourse to some system of drainage of that kind, the difficulties of construction of the dry dock at Southampton and of the canal to which he had referred in Belgium would, he was sure, have been enormously increased.

Mr. Athol L. Anderson, referring to Dr. Brysson Cunningham's remarks suggesting that the strength of the dock and the quay-wall might be excessive for commercial requirements, observed that as far as the Admiralty were concerned he was only too glad to see the conservative way in which the dock had been designed, because in addition to its being an immense commercial asset it might be called upon in an emergency to take a very large capital ship. With large and heavy capital ships the pressures on the keel-blocks under certain portions of the ship were very much larger than anything met with in commercial practice, and therefore he was glad to see that there was probably a factor of safety beyond what was perhaps necessary for commercial work, which would be available if the dock were required for use by capital ships.

There was one point about the dock which had caused him some little surprise. At the Admiralty they had always looked on commercial work as being in advance of their own, as they were very conservative, and could not afford to take up new methods until they had been thoroughly tested. They had, however, definitely abandoned the use of timber-slides for a good many years past, finding that they were a nuisance. The openings alongside the dock had to be covered over, whilst the covers themselves had to be of a light nature so that they could be lifted off; they were therefore usually made of timber, which wore out in course of time. Further, the covers were often situated where it was desired to lay a railway siding. All equipment was therefore lowered or lifted by a crane on the dock-wall in naval dockyards. In view of that fact, he would be interested to know why timber-slides were still used in commercial practice.

Mr. C. P. Taylor, referring to the two cross-sections of the quay (Figs. 7 and 8, pp. 259 and 260), said that the difference in depth was considerable, whilst the only alteration in design occasioned by that difference appeared to be the concrete slab at the top over the triangular void behind the monoliths. He could not help feeling that the cost of that slab was bound to have been negligible, compared with the cost of the extra sinking involved in the original design. Mr. Wentworth-Sheilds had referred to the prevalent ignorance on the question of earth-pressures, and those who had that subject frequently before them—as he himself had, although on a very small scale, compared with the work described in the Paper—would find it comforting to know that something definite was being done to provide information which would form a reliable basis for calculation. Was the factor of safety in the modified design as good as in the case of the original design? That question was not raised in any spirit of criticism, because risks could not be incurred in work of the kind in question if they could possibly be avoided, but it would be of interest to know whether the modified design had been adopted on account of any particular circumstances other than the difficulty of sinking, and whether it had given the same stability.

Mr. E. M. Fitt thought that it might be of interest to amplify the information already given by the Author in regard to some of the principal machinery used in the construction of the King George V graving dock. For the excavation in bulk, the Contractors had decided to use steam excavators, for the reason that, in their opinion, at that time steam was to be depended upon to a far greater extent than either petrol or diesel machinery for continuous work without breakdown. That decision had been taken with the knowledge that the fuel cost would be many times greater. The whole of the work was done by one No. 10 Ruston dragline with a 1¾ cu. yd. capacity bucket and two Ransome dipper-bucket excavators with 1¼ cu. yd. capacity buckets, either of which could be converted for dragline work when required. The mud, gravel and clayey sand (commonly called greensand) was transported in steel tipping wagons of 11 cu. yds. capacity, hauled by steam locomotives. The railway tracks for all excavation and concrete work were 4-ft. 8½-in. gauge, with flat-bottomed rails weighing 70 or 75 lb. per yd. To consolidate the filled material behind the walls, diesel caterpillar tractors were used, fitted as bull-dozers to spread the material in layers about 4-in. deep. The excavation of the trenches, which were approximately 40-ft. wide at the surface, was carried out as far as possible by means of heavy-type whole-tined Priestman grabs and 7-ton steam cranes fitted with double drums.

The central plant for washing gravel, and for concrete mixing, was arranged to take advantage as far as possible of the natural differences of level of the ground on the old foreshore. The washing plant consisted of two large drums, each capable of handling 75 cu. yds. per hour; a belt conveyor with a capacity of 120 cu. yds. per hour raised the washed gravel to the overhead bins. The concrete was mixed in two Rex mixers of 1 cu. yd. capacity each. The cement was transported in bulk from the works on the Medway in common-user railway trucks, the trucks being lined inside with steel sheets, and covered with two tarpaulins. It was interesting to note that no cement was spoilt in transit during the whole period of contract. When concreting was in full operation, a train of wagons arrived every morning. The trucks were run into a high-level cement shed, so designed that the cement could be shovelled out of the truck direct into large hoppers; the latter had only very small openings at the top, with the object of preventing pollution of the air by dust. That arrangement worked very well, and there was actually no more dust than in any ordinary cement shed when large quantities of bags were being handled. The cement was conveyed by means of a horizontal screw conveyor and vertical bucket elevator to a bin over the mixers. For six months at the peak period a steady output of 10,000 cu. yds. of concrete had been handled by that plant per week, working 10½ shifts of 10 hours each.

While the floor was being concreted, an auxiliary plant had been rigged over the east dock-head, by means of which the output had been increased to a total of from 12,000 to 15,000 cu. yds. per week. Cement was transported in 4¼ cu. yd. skips for the floor, and in 1½ cu. yd. skips for the walls, both of the bottom-door type. The large skips were handled by 12-ton electric derrick cranes, and the smaller ones by 7-ton steam travelling cranes and by 7-ton electric derricks.

The following were some of the chief items of plant:—

Eleven 7-ton steam cranes.
Three 5-ton steam cranes.
One 15-ton electric derrick-crane.
Two 12-ton electric derrick-cranes.
Six 7-ton electric derrick-cranes.
Eighteen steam locomotives (mostly six-coupled, with 13-in. diameter cylinders).

The wall shutters were constructed of timber on the cantilever principle, 18-ft. long by 5-ft. deep, with legs extending vertically below. They were bolted to the concrete. A platform was attached to the legs to facilitate the removal of the bolts. The concrete floor was commenced at the entrance, and was constructed with a central block about one-third of the width of the floor, followed on each side by a side block. The central block was generally about 25-ft. in advance of the side blocks. The

* Reproduced from the Journal of the Institution of Civil Engineers, by permission of the Council. The Paper appeared in the issue of this Journal for July, August and September.

Southampton Docks Extension—continued

shutters to form those blocks were constructed of timber. The ends of all three blocks and the sides of the central block were each made in one piece, which was lifted by a 12-ton derrick travelling on the finished floor. That crane had done most of the placing of the concrete in the floor.

Mr. W. T. Halcrow observed that the Author dealt very briefly with the layout of the important extensions of the Port of Southampton, and referred to two schemes differing radically in principle, one embodying the jetty system and the other the continuous quay. It would be of interest if the Author were to give some of the reasons for the decision taken to adopt the long quay. In the absence of the views of the seamen who had to handle the largest vessels afloat, for which the quays were provided, he would be inclined to believe that the line which had been adopted would have the disadvantage of placing vessels at right angles to the prevailing winds, and that difficulty would arise in berthing and hauling off owing to the large surface presented to the wind. Had that difficulty been experienced? The advantages from the economic point of view of a continuous quay over jetties were well known. With the former ships could be moored bow to stern with no waste of quay-space, whereas in the latter system, with, for example, jetties 1,000-ft. in length, one berth would normally be used by one vessel only, whether it was 1,000-ft. long or only 600-ft. long.

Before the War his firm had been asked to prepare schemes for the development of a system of docks at Keyhaven, on the flat land lying to the east of Hurst Castle; as an alternative to the extension of the dock system at the head of Southampton Water for large vessels, some advantages had been claimed. The site gave easier access for ships from the sea, and with deep water in the Solent immediately adjacent to the dock system, the necessity for extensive dredging, as was required in the channels to Southampton, would have been avoided. Railway connection could have been made with the Lymington branch of the Southern Railway. An ocean quay was to have been incorporated so that vessels calling with mails and passengers could come alongside, instead of anchoring in Cowes Roads and being served by tender. Earlier in the century the ocean-quay scheme had reached a stage further than the dock scheme referrd to, in that powers had been obtained for an extension of the railway and for the construction of the quay.

Many matters of interest were described in the Paper, not least of which was the adoption of the well-point method of lowering the ground-water level, both during the construction of the graving dock and permanently. The sand to be drained appeared to have been sufficiently coarse to allow the fine copper-mesh filter to work satisfactorily. If the sand had been very fine he doubted if that method would have been effective. When engaged on the construction of a large graving dock on the Tyne he had had experience of the difficulties encountered in building the foundations on wet running sand. In that case an attempt had been made to lower the ground-water level by sinking cylinders to a depth below foundation level, and then forming filters in the bottoms of the cylinders. The filters consisted of layers of coarse sand, with gravel and crushed stone and larger stone in layers above it, but the system had not proved satisfactory; the running sand was so fine that if the filters were made of material sufficiently small to keep the sand out, the water would not flow through. Ultimately, the most difficult sections of that dock had been dealt with by boxing in the sand with cast-iron sheet piling. Did the Author consider that the filters for the well-points would have an indefinite life, and if not, was there any method of renewing them? If that were not possible, new wells would presumably have to be sunk to replace them.

The large masses of concrete placed in a comparatively short period were bound to have contracted appreciably on setting. It would be of interest if the Author could give particulars of the steps taken to deal with that matter.

In regard to the consolidation of the material forming the reclamation, Mr. Halcrow's experience was that settlement sometimes continued for a considerable period. Had any trouble been experienced? From the sections (Figs. 7 and 8, pp. 259 and 260) it would appear that the buildings only were carried on piles and that the railway, road, and cargo-shed floor were carried on the filling.

The Author, in reply, thanked Mr. Wentworth-Sheilds for his personal references and for what he had said about the team of engineers engaged in the work. Those who knew Mr. Wentworth-Sheilds would realise that the pleasure was not all on one side, and that it had been a very great pleasure to serve under him.

Sir Henry Japp had referred to the relative merits of jetties and long quay-walls, and had said that he had heard that there was some difficulty in berthing ships at Southampton alongside the quay-wall. It was quite true that the jetty scheme had many advantages, but the expert opinion of master mariners, marine superintendents of the various shipping companies, and the pilots, all of whom were consulted and with whom many meetings were held, was by no means unanimous on the side of the one scheme or the other; that was why he had said in the Paper that the advantages of one appeared to outweigh those of the other, and they did. The decision taken was, on the advice of the late Sir Frederick Palmer, reversed, but not so much from Sir Frederick Palmer's point of view that there was difficulty in navigating, as from the point of view that the long-dock scheme was more flexible than the jetties. The five jetties were to have been each 1,000-ft. long, and ships could have been berthed on each side of each jetty, thus providing ten 1,000-ft. berths. It was considered, however, that there would never be ten 1,000-ft. ships in Southampton at the same time, and that the majority of ships berthed would be more like 600-ft. in length, so that the jetty scheme would frequently mean using 1,000-ft. berths for 600-ft. ships, which was not strictly economical. It was much more flexible to have the long quay where the ships could be berthed stem to stern right along. So far as difficulties of navigation were concerned, he thought that they were more fancied than real; there had been only one occasion when a ship had been held on the quay through adverse weather conditions. The idea that the long quay was not good from the point of view of handling ships was therefore, he thought, exaggerated.

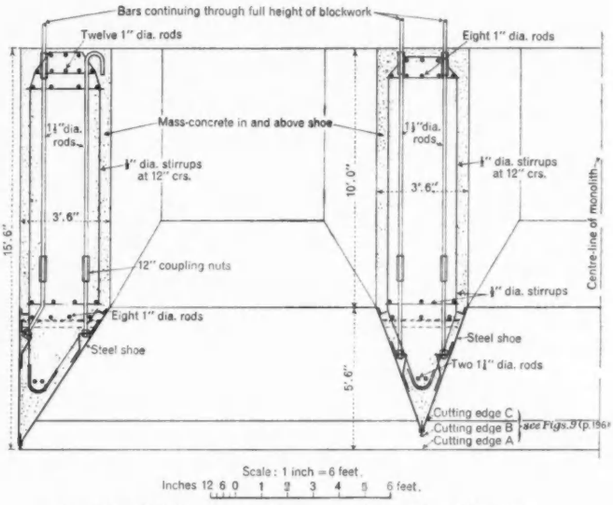


Fig. 22. Reinforcement In and Above Monolith-Shoes

He had been interested in Sir Henry Japp's description of the method envisaged by his firm when tendering for the dock, and it would be interesting to know whether that method—namely, the use of high-pressure jets at the toes of the shoes—would have been effective. During the execution of the work, whenever difficulties had arisen in trying to deal with the greensand (which, incidentally, was not a pure sand but had an admixture of clay with it), and to get it out from under the cant-plates, all kinds of expedients, including the use of high-pressure jets, had been tried until Mr. Donald Mackenzie had invented the "scarifier" and the "surger." Had it been pure sand, probably the high-pressure jets would have dispersed it, but since there was an admixture of clay, it seemed that that held the material together so that the jets merely bored a hole in it. The reinforcement in the monolith shoes was shown in Fig. 22. The wells were not always cleaned out by divers; occasionally, when it seemed desirable, divers were sent down to inspect them, but, generally speaking, the wells were cleaned up by grabs.

In reply to Mr. Allen's question, the Author stated that there was no limit laid down for the minimum permissible distance vertically between the monoliths, but no monolith being sunk was permitted at any time to be more than 30-ft. deeper than its neighbour. With regard to the horizontal distance between the monoliths, they were pitched, as stated in the Paper, 4-ft. apart in the first half of the quay, and 7-ft. apart in the second half. The spaces were at times, of course, reduced and at other times increased, by reason of the monoliths leaning towards, or away from, each other during the process of sinking, and extreme care had to be taken that the shoe of one monolith did not impinge on the wall of its neighbour. That was a matter to which the contractors had given a considerable amount of thought, and they had dealt with it successfully. The usually accepted method of sinking a single monolith was that, if it were high on one side, that side would be weighted while sinking was stopped on the low side, and grabbing was continued on the high side; the monolith would then come back to a level position once more. With the monoliths at Southampton, however, possibly due to the nature of the ground and possibly to their size, they would not return to their correct position in that way, and frequently in order to regulate the inclination and to bring them back to a

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vertical condition once more, it was necessary to go three or four monoliths away, and to sink two or three to ease them back.

With regard to the cost of the work, to which Dr. Cunningham had referred, the Author was in the same position as that in which most Authors probably found themselves. At Southampton it was particularly difficult to give definite figures; for instance, if Dr. Cunningham asked how much an acre it cost to reclaim the land, it would be possible to give him several correct answers! Similarly, a number of correct answers could be given for the cost per linear foot of the wall. The fact was that there were several things bound up one with the other; it was necessary to dredge a deep-water channel and to dispose of the material, it was necessary to reclaim land, and it was necessary to build a quay-wall, but it was almost impossible to say how much of the expenditure should be allocated to each of those three headings taken in isolation. For instance, some of the gravel obtained from dredging in the channel was used to form the main bank through which the monoliths were sunk, and some for concrete in the quay-wall, graving dock, and other works; part of the main bank was subsequently dredged away and the material used for reclamation, whilst the gravel excavated from the bank during monolith sinking was partly used for concrete in the quay-wall and partly for reclamation. Unit prices under such circumstances might be misleading. As far as the overall costs of the works were concerned, the money spent on them was about £6¾ million. The graving dock cost about £1¼ million.

Dr. Cunningham also referred to the stability of the works and to similar works of lighter construction on the Continent and in America. The Author had not seen the American works, although he knew them well enough by repute, and from Dr. Cunningham's own books, but he thought that there was bound to be a critical point at which light work of that kind ceased to be really economical. In deep water he gravely doubted whether such light works were really economical. The walls provided at Southampton would stand without a penny of maintenance being spent on them for many years to come, and that was something which could not be said of timber-pile quay or jetty construction, at any rate in the waters of Southampton. In the Weser at Bremerhaven, and at Bremen itself, he had seen quay-walls built with timber piles in a very cheap manner, but it would be impossible to do that at Southampton, and no doubt at a great many other places also. He was not decrying for one moment what Dr. Cunningham had said, because he thought that there was a good deal in it, and the Southern Railway had often wished that they could build such works.

The accumulation of mud in the dredged berth alongside the quay had not been excessive. It had been necessary to do maintenance-dredging there, but no more than in any other part. What the future would show he did not know. It might be that in time the banks and the conditions generally would have stabilised themselves, and that there would be still less to do. There had been no settlement of the monoliths anywhere, so far as it had been possible to ascertain.

Book Reviews

Water Engineering, by the late Charles Slagg and F. Johnstone-Taylor; 2nd Edition, pp. xviii + 156, with illustrations. Price 8s. 6d. net. London, 1938: The Technical Press, Ltd.

River Engineering: Principles and Practice, by F. Johnstone-Taylor; 2nd Edition, pp. xxii + 118, with illustrations. Price 4s. 6d. net. London, 1938: The Technical Press, Ltd.

These two books may be reviewed together, since they are evolved from a single publication, "Water Engineering," by the late Mr. Charles Slagg. Recognising the deviating trend in modern practice, Mr. Johnstone-Taylor has separated the two subjects and limited the treatment of water engineering to the field of domestic water supply, with which, in these days, it is almost entirely associated, dealing with the subject of river regulation and training in what is practically a new work, though it embodies some matter from the original "Water Engineering."

In water supply for domestic purposes, readers of this Journal are not greatly interested, but the province of river engineering includes a number of features which come within the purview of port affairs, perhaps for the most part indirectly and as side issues, but none the less having a degree of importance. Mr. Johnstone-Taylor divides his small and compact treatise into four chapters, headed respectively: Hydraulic Considerations, Embankment Work, Weirs and Control Work, and Navigation Work. These four divisions cover a very great deal of ground and, within the limits he has set himself, the author could obviously only deal with them in general, not to say superficial, terms. As a brief, introductory, pocket-size, manual, the book will be a handy guide to the student, enabling him to take a general comprehensive view of the field of operations. The chapter of Navigation Work discusses such a variety of topics as the process of silting, the functions of dredgers, lock design, bridges, estuary work and land reclamation plant, all within the space of some 30 pages. So great a degree of compression clearly does not admit of thorough treatment and, in fact, the author assumes a certain degree of knowledge on the part of his readers. He affirms in his Preface that "this particular branch of Civil Engineering in common with coast defence works, can hardly be adequately treated on paper at any length, owing to the fact that a lengthy, one might even say lifelong, study of local conditions will tax the experience of the engineer-in-charge considerably more than the actual design and construction of necessary works.

Both books have serviceable indices, are well printed, with a number of diagrams and a few plates, and are neatly bound.

Publications

The Port Authority of **Ghent** has issued an artistic booklet in four languages—"Haven Ghent, 1937"—descriptive of the port and its activities. It contains statistics of shipping and freight movements with a list of shipping lines using the port. There are a number of attractive photographs.

It is interesting to note that Great Britain continues to be the principal importing country for the Port of Ghent. During 1937, the number of British vessels which arrived was 945, with a net tonnage (Moorsom) of 515,629. Their cargoes were chiefly general, with coal, pitch, coal-tar and fertilisers. The principal exports sent to England consisted of general merchandise, iron and steel, and scrap.

Rotterdam is another port which has engaged in artistic publicity. Adopting as a slogan on the cover: "Rotterdam, freer than a Free Port," Dr. Kolff, the Secretary to the Municipal Port Authority, has composed an essay (published by the "Stichting Havenbelangen"), showing that while theoretically it is not, in reality Rotterdam is a Free Port, by reason of a system of Custom House Sheds, Bonded Warehouses, and "Flag" and "Open" Conveyance. This permits of the reception and local transfer of dutiable articles and material under effective customs supervision.

"Open" conveyance is stated to stand on about the same level as "flag" conveyance. The latter is explained as follows: "Carriers of good standing and repute may provide their motor truck or dray with an identity token (a certain leaden seal). This token gives the carrier the right to convey goods by motor truck or dray under "flag" conveyance. During the time that the goods in question are being conveyed, a metal flag with a green R on a white field must be carried on the cabin or box. . . The condition to be fulfilled is that conveyance must take place within a certain time and along a certain route. In view of the great importance of quick transit for the goods the police, when regulating the traffic on the bridges, give precedence to motor trucks conveying goods under "flag." In cases of goods paying heavy import duty, "flag" conveyance proper is not permissible. The truck must be accompanied by a Government official. Between bonded warehouses, there is "open" conveyance. The main contention of Dr. Kolff's argument is that there is the same freedom of movement in Rotterdam as in a Free Port. A list of Bonded Warehouses is given, and there is a coloured plan of the port, showing the customs sheds, bonded warehouses and the territory assigned to "flag" conveyance.

Messrs. Redpath, Brown and Co., Ltd., have forwarded a new and up-to-date issue of their handbook, "Structural Steelwork," and a booklet, "Working Stresses in Steel Columns," both of which contain a great deal of tabular dimensional and general information which will be of great use to constructional engineers and designers. The publications are not for sale, but are supplied to members of the profession and to approved applicants.

The "Queen Mary" Docked without Tugs.

Owing to a strike of tug-workers at New York during the middle of last month, no tugs were available, and Commodore R. B. Irving, the Captain of the White Star Liner "Queen Mary," decided to dock the liner under her own power. The operation was completed in 34 minutes without incident, except for the snapping of a hawser as the vessel was being warped in alongside the pier.

New Free Port on the Danube.

It is announced by the British-Hungarian Chamber of Commerce at Budapest that the Hungarian Government has established on the Danube, about two miles south of Budapest, a free port of some 1,500 acres. It is equipped with three basins of 40, 18 and 14 acres respectively, with three wharves having a total area of 350,000 sq. ft. There are also large silos capable of receiving 220,000 tons of grain in bulk and 10,000 tons in bags, which can be handled at the rate of 400 tons per hour. Bonded warehouses with an area of 140,000 sq. ft. are in course of construction. Cargoes can be conveyed by modern sea-going vessels of 600 to 1,000 tons to Egypt without transhipment.

Permanent International Association of Navigation Congresses

Seventeenth International Navigation Congress, Berlin, June, 1940

Programme of Questions and Communications

The following programme of questions and communications has been issued in connection with the XVIIth International Navigation Congress, which will be held in Berlin, in June, 1940.

At the annual meeting of 31st May, 1938, the Permanent International Commission decided that the papers presented at the Congress should only be published in extenso in the original language, either German, English or French, but that they should be accompanied by a resumé, which will not exceed in length the fifth part of the text of the paper, and will be translated into the two other languages.

The General Reports, as before, will be published in the three official languages of the Association.

The Commission have also decided that the prescriptions of the statutes with regard to the extension of papers and plates shall be strictly observed; in consequence, the length of papers (resumé not included) will not be allowed to exceed 20 printed pages of 400 words and two plates at the most, of 22 cm. × 53 cm. inside the frame, will be admitted.

Members of the Association, wishing to present a paper, are requested to apply to the chief of the delegation of their country.

Programme:—

Section I.

INLAND NAVIGATION

A.—QUESTIONS

1st Question

Acceleration of transport on inland navigable waterways:—

(1) Importance of acceleration of transport, having regard to the rate of freight and to the particular role of inland navigation.

(2) Measures to be taken for accelerating transport:

(a) Measures concerning construction and operation of navigable waterways and inland ports (e.g., lighting of the waterways; towage);

(b) Measures concerning technical construction of craft and of their motive power;

(c) Measures concerning commercial operation of the navigation. Organisation of staff and plant services;

(d) Classification of navigable waterways with a view to the traffic of ships of uniform dimensions;

(e) Possibility of international standardisation of the measures above in the different States whose systems of navigable waterways are interconnected.

2nd Question

Means of dealing with large differences of head:—

(1) Comparison of the various possible solutions concerning the construction and water consumption from the technical and economical standpoint. Works constructed and contemplated.

(2) Operation results.

3rd Question

Function of storage reservoirs (in main or side valleys) in regulating flow of water, whether canalised or not, in reducing floor waters. Case of water used for power. Study of models.

B.—COMMUNICATIONS

1st Communication

New development in the design and construction of locks.*

(a) Type of foundation: use of coffer-dams (type of sheet piles), of freezing, of lowering of the water level, of piles (wood or reinforced concrete), of cased wells, of compressed air caissons, etc.

(b) Design and construction of walls and sills (including monoliths); stability data, (especially in regard to important changes in water level and to the nature of the soil);

(c) Mitre gates and their operating machinery, filling and emptying (taking account of excess head of water upstream), culverts, sluice valves and penstocks, with operating machinery, pumping stations in the case of artificial topping-up of water (method of construction and of calculation);

(d) Design of lock components to permit complete or partial release of water and their stability under all circumstances;

(e) Measures taken against seepage and other escape of water, according to uplift pressure resulting from local conditions.

* Each of the subjects under (a), (b), (c), (d) or (e) may be considered separately.

2nd Communication

(1st and 2nd Sections)

Protection of embankments and bed in inland and maritime waters, and in overflows or weirs:—

Influence:

(a) Of the form and the dimensions of the cross section;

(b) Of the form, the speed and the propulsion-system of vessels;

(c) Of the speed of the flows and especially of the waves of translation.

Comparison, from economical standpoint, between solid protection of the bed and embankments and an increase of the cross-section.

3rd Communication

Value, from the economical standpoint, of large inland navigable waterways, and particular ways of developing inland navigation traffic:—

(a) Possibility and results of translation into figures of value from an economical standpoint, of large inland navigable waters, taking into account the traffic, as well as the other functions of these waterways (water supply, power production, high water protection, etc.).

(b) The motor barge for goods transports; its dimensions and equipment; its utilisation on canals and rivers; experience acquired and economic results.

(c) High value merchandise traffic.

(d) Tanker traffic.

(e) Container traffic, etc.

Section II.

OCEAN NAVIGATION

A.—QUESTIONS

1st Question

Regularisation of natural and artificial estuaries, including estuaries of small dimensions, tideless or otherwise.

Improvement of that part of the stream affected by the sea and tides.

Recent observations and results. New methods.

Comparison of results obtained with those given by the tests on models or by calculation.

2nd Question

Facilities of port depots for loading, unloading and storage of fuel oils (including mechanical equipment).

Segregation of such depots (and refineries) from other parts of ports; other special measures for reducing risks from fire or other causes.

Best location for oil refineries within port boundaries.

Facilities for movement of fuel oils inland from the port.

B.—COMMUNICATIONS

1st Communication

Comparison and co-ordination between the different means of connecting ports:—

(a) With their hinterland (inland navigation, coasting trade, railways, telpherage, ordinary and special roads, aerial navigation) with special reference to the nature of the goods to be handled. The examination is to be principally directed to the most modern methods and not to retraversing in detail methods which have been extensively discussed before, e.g., waterways and railways.

(b) With one another: facilities for air- and seaplanes in ports.

2nd Communication

Recent evidence and new preventive measures in regard to disintegration of mortar and concrete in sea-water.

3rd Communication

A land traffic-route crossing a maritime canal or a sea-port canal:—

(1) Determination of minimum headroom.

(2) Comparison of cost of installation and operation of a high bridge, movable bridge, tunnel, transporter bridge and ferry, with due reference to the limitations severally imposed by them on land and water traffic.